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An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

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R. H. WALPOLE,
Secretary.

Company's Offices,
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FRANK C. SMITHARD,
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26th June, 1920. H 534

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Education Offices,
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1920. H 541

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Cardiff. H 629

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W. SHATON,
Secretary.

H 707

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Applications for the Position

of PRINCIPAL ASSISTANT to their Engineer-in-Chief.

Applications with copies of testimonials, stating age, qualifications and salary required, to be addressed to the undersigned not later than Saturday the 4th day of September, 1920.

In addition to being a fully qualified Civil Engineer, applicants should have a good knowledge of Mechanical and Electrical Engineering.

By Order of the Board,
L. A. F. WARNER,
General Manager and Secretary.
Dock Office, Liverpool, 8th July, 1920. H 603

ASSISTANT INSPECTOR OF WIRELESS TELEGRAPHY, GENERAL POST OFFICE.

There is at present a

VACANCY for an ASSISTANT INSPECTOR OF WIRELESS TELEGRAPHY in the Post Office. Candidates should preferably be between 26 and 28 years of age; they should be graduates in Physics or Electrical Engineering (preferably with post-graduate experience in an electrical laboratory or workshop, or they should have had experience as Naval or Military Experts); and they must have had practical experience of Wireless Telegraphy and Electrical Engineering. They will be required to pass a medical examination, and may be called on to serve abroad. Salary, £300 to £350 by increments of £15 a year, and then to £450 by increments of £20. In addition, War Bonus is paid on the Civil Service scale, which, at the present rates, would increase a salary of £300 to £390; £350 to £411; and £450 to £757. Applications, with full particulars of qualifications and experience, and copies of recent testimonials, should be sent to the SECRETARY, General Post Office, London, E.C. 1, on or before the 31st July. H 601

OFFICERS REQUIRED FOR SERVICE ON INDIAN RAILWAYS.

Messrs. RENDEL, PALMER & TRITTON, Consulting Engineers, are prepared to receive

Applications (by letter only)

for the following APPOINTMENTS:—
EIGHT ASSISTANT LOCOMOTIVE SUPERINTENDENTS,

Two of these officers are required on a commencing salary of Rs. 620 rising according to Company's Rules to Rs. 800 per calendar month. One must be especially experienced in Locomotive Running Shed and Footplate Work, and the other must have special experience of Modern Railway Workshop practice and maintenance of Plant.

Six officers are required on a commencing salary of from Rs. 420 to Rs. 550 according to age and qualifications.

Candidates should not be less than 24 years nor more than 28 years of age (unmarried men preferred) and must have had a sound general education, and have gone through a full course at a recognised Engineering and Technical College. They should have received a thorough training as Locomotive and Mechanical Engineers, preferably on a British Railway.

Other things being equal, preference will in all cases be given to those who have had Running Shed and Main Line Firing experience. Men who have been wounded in the War will be acceptable, provided they are fit for their work

TERMS.—Three years' agreement in the first instance, and first-class free passage to India, and home again on satisfactory termination of engagement.

Selected candidates will be required to pass a strict medical examination before final appointment.

Letters of application giving the Candidate's age (whether married or single), details of general and technical education, training and subsequent career (in chronological order) with dates, accompanied by copies only of Testimonials, War Certificates, &c. Should be addressed to Messrs. RENDEL, PALMER AND TRITTON, 13-14, Dartmouth Street, Westminster, S.W., not later than 17th July, 1920. H 646

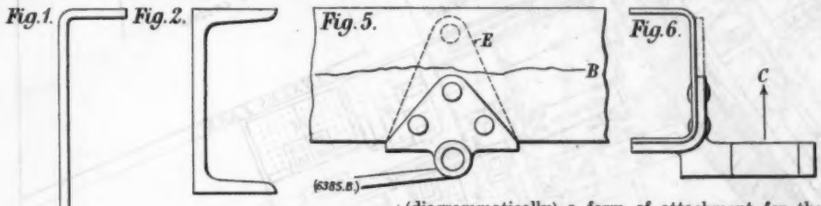
DEFECTS IN MOTOR VEHICLES AND THEIR REMEDY.

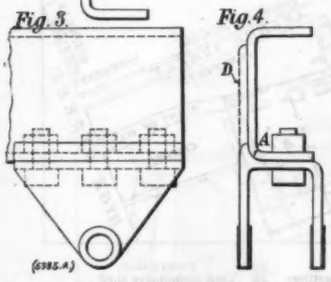
By F. STRICKLAND.

(*Continued from page 785 of vol. cix.*)

IN all classes of vehicle, frames gave a great deal of trouble, both with regard to their cracking and also with rivets coming loose. Frames of light cars are invariably of pressed steel, but in the case of the lorries in use in France some had frames made of pressed steel and some of rolled channel. It was very noticeable that the channel steel frames gave a great deal less trouble than the pressed type, both from breakage and loose rivets. Some types of lorry with pressed frames were very free from breakage, but the large majority of makes had instances of broken frames, and in some of the makes broken frames were the rule rather than the exception. In fact, in some cases frame breakages were so common that it became the practice to strengthen the frames in the places they were known to be weak without waiting for them to show cracks. As a rule also the frames were patched as soon as cracks appeared, so that they did not actually break right through.

These cracks were of two types. First there were frames which cracked vertically near the centre of the lorry from the bending stress of the total load. Secondly there were cases of cracks from local





stresses. With regard to the first it appears at first sight curious that the pressed steel should have suffered so much more than the channel. The pressed frame has the advantage that the depth can be varied according to the bending moment, and therefore it should theoretically be the stronger of the two. The cracking of the pressed frame may therefore be due either to the frames being made too light for their work, or it may be due to the fact that the section is too deep in proportion to its thickness.

Figs. 1 and 2 give about the usual proportions of pressed and channel steel frames as used in ordinary 3-ton lorries, and it will be seen that it is usual to make the pressed frame of deeper section than the channel, but thinner. It appears that in practice all these frames, whether pressed or channel, are liable to spring a good deal under the influence of the various loads to which they are subject. This springing can be easily seen when a loaded lorry is started by letting the clutch in with a jerk, especially if the vehicle has a covered body, as the movement between the cab and body is considerable. The shallower section of the channel will be stressed lower by such springing than the deeper section of the pressed steel.

In some cases the cracking of frames of all kinds was due to bad detail design. By this time it ought to be realised by designers that holes should never be drilled in the flange of a frame but that all attachments should be made to the webs. Yet there were instances of parts being attached by holes, sometimes of large size, through the bottom flange of the frame, which is the tension member. Naturally this very much increased the tendency to crack there as it produced local weakness. One type had the gear-box carried in this way, and the large majority of the frames cracked through the bolt hole. The design was altered, and attachment made to the web, when breakages were greatly reduced.

Even where attachments are made to the webs, and not the flanges, care ought to be taken in the disposition of the holes. One type of frame was very liable to crack at a point where there were three rivet holes vertically over each other, this making a weak place.

In the case of the light cars the frames were very apt to crack at the point where the frame inswept. In the majority of frames the back part is a great deal wider than the front, and the frame has a rather sudden double bend just behind the engine. Some frames are, however, parallel, and it appears that this is far the better arrangement, as such frames are far less liable to crack.

Again, where cantilever springs are used there is a very much heavier bending moment at the point of attachment than with semi-elliptic springs, and this is not always allowed for. As a consequence a great many frames cracked at the point of attachment of the cantilever spring.

Apart from these breakages due to the bending moment on the frame, there were a good many cases of frames cracking from local weakness. An instance of this is shown in Figs. 3 and 4. This shows (diagrammatically) a form of attachment for the front dumb iron which caused a great deal of trouble. As the dumb-iron is only attached to a very small part of the bottom flange of the frame, the latter cracked at A, and if not strengthened, the bottom flange tore right away. If the dumb-iron were made as shown in dotted lines at D and suitably bolted to the web, the stress would be properly distributed. This type of attachment stood excellently on the channel frames as the latter has greater local strength, and it can of course be made satisfactory on the pressed steel frame if this is suitably stiffened.

In one make of car the front of the back spring was carried in a bracket much as Figs. 5 and 6. The result was that the frame cracked along the line B owing to the local stress set up by the pressure of the spring at C. If the bracket were made as shown by the dotted line E, the stress would be properly distributed.

Loose rivets were a great source of trouble, so much so that large numbers were out out and turned bolts substituted. The bolts had the advantage that they were easily tightened up when they got loose, but this means attention which should be unnecessary. Some makers gave up rivets altogether and used bolts, and it certainly appeared that frames bolted together gave less trouble than frames riveted. This may, however, not really prove the superiority of bolts over rivets, for the bolts used were usually larger in diameter than the rivets they replaced. The fault of most riveting in the frames appeared to be that the rivets were too small, and often not properly closed. If rivets of proper size are used, and closed with a hydraulic riveter, there should be no trouble whatever. In the case of the 3-ton lorry it appears that the rivets should be not less than $\frac{5}{8}$ in. There were in use in France several makes of lorry with channel steel frames fastened with rivets of this size in which loose rivets or cracked frames were practically unknown.

The general conclusion appears to be that as at present constructed the channel frame well riveted with rivets of proper size is the most satisfactory for lorries, but that there is no theoretical reason why the pressed steel frame should not be made equally satisfactory. With regard to weight the pressed has probably the advantage, but the difference cannot be very great, and if the pressed frame is made to give as little trouble as the channel the difference will be very small indeed, especially when the extra weight of the brackets necessary to distribute the load on the pressed frame is taken into consideration. With regard to cost the channel will always probably be the cheaper.

In cars the only type used is, as we have said, the pressed frame. Here improvement appears to be a matter simply of detail design and possibly material. It is evident that there is room in many English frames for improvement in these respects as they were very much more liable to breakage than some foreign frames which were much lighter in proportion to the load they carried.

(*To be continued.*)

THE LINCOLN WORKS OF MESSRS. RUSTON AND HORNSBY, LIMITED.

(*Concluded from page 10.*)

THE WOOD WORKS.

The wood works, a plan of which is shown in Fig. 25, on page 34, with the key to the shops annexed, covers 18 acres. In addition to the manufacture of threshing machines, clover hullers, elevators, chaff cutters, rice-threshers and other kinds of machinery for dressing seed and grain, which formerly constituted the output of these works, the production of an agricultural paraffin tractor and the manufacture of bodies for the Ruston Hornsby motor car are now undertaken as well. The works have been extended and special departments established for these latter products. Another special department exists for the manufacture of the Ruston centrifugal pumps.

A feature of the thresher shops is the method of painting by dipping, which has been developed to the fullest extent, and for which the most modern facilities are provided. All details are painted and varnished in this manner, thus effecting great economies in labour and material as compared with hand work. The engineering section of these works is very large, the main machine shop covering 27,180 sq. ft. In this section all the metal parts for threshing and similar machinery are manufactured.

The Paraffin agricultural tractor, already alluded to is of the four-wheeled type, the rear driving wheels being 48 in. diameter by 12 in. face. The tractor is driven by means of a four-cylinder vertical engine, running normally at 900 r.p.m. The cylinders, which are $4\frac{1}{4}$-in. bore by $5\frac{1}{2}$-in. stroke, have removable sleeves and a detachable cylinder-head with overhead valves. The tractor has two speeds forward and one reverse, these being obtained by means of sliding gears. The final drive is through straight-tooth pinions and spur gear. Hyatt roller bearings are fitted generally throughout the machine, 13 bearings of this kind being embodied in the design. Ignition is effected by means of a high-tension magneto. The carburettor is of the petrol-paraffin type with vaporiser for the heavier fuel. For driving stationary machinery the tractor is fitted with a belt pulley 18 in. diameter by 6-in. face, running at 430 r.p.m. and started and stopped by means of the main clutch. The tractor weighs 33 cwt. and is powerful enough to pull a three-furrow plough with ease.

The motor body department is as we have mentioned, a recent addition to the wood works. Here the chassis delivered from the car works are received and equipped ready for the road. Body building, upholstering and painting are all carried out on a highly-organised system, and in accordance with the principles of rapid production which is a feature of the works.

THE NAVVY WORKS.

The manufacture of steam navvies for excavating railway cuttings, docks, &c., or for the mining of ironstone or any other surface deposit of minerals was first started by the firm of Ruston, Proctor and Co., Limited, in 1876, and has always continued to be a prominent part of their activities. The construction of these machines is now carried on in extensive new works, a plan of which is illustrated in Fig. 26, on page 35. Three of the bays of these works deserve special mention, having an aggregate floor space of 110,000 sq. ft., and being exceptionally lofty in order to permit of the

travelling cranes passing over the largest machine under erection. The first bay is occupied by the manufacture of the structural steelwork of the jibs and other parts, and contains the usual equipment of machines suitable for such work. In the centre bay the erection of the navvies is carried out; two views of this bay are given in Figs 27 and 28 on Plate V. The underframes are mounted at one end of the shop, and the embryo navvy works its way on its own wheels steadily to the other end, various parts being added to it at every stoppage until it finishes its journey as a completed machine. There are two railway tracks laid from end to end of the erecting bay, so that two lines of navvies proceed simultaneously to the exit doors. The output of the shop is between two and three finished navvies per week. Alongside the erecting bay is the machine and fitting bay, where the mechanical details are prepared. These are manufactured for stock, and after inspection are sent to a large finished part stores at the end of the erecting shop, whence they are withdrawn in sets as required by the erectors. The Navvy works are self-contained except as regards castings and forgings, which are obtained from the other works of the firm.

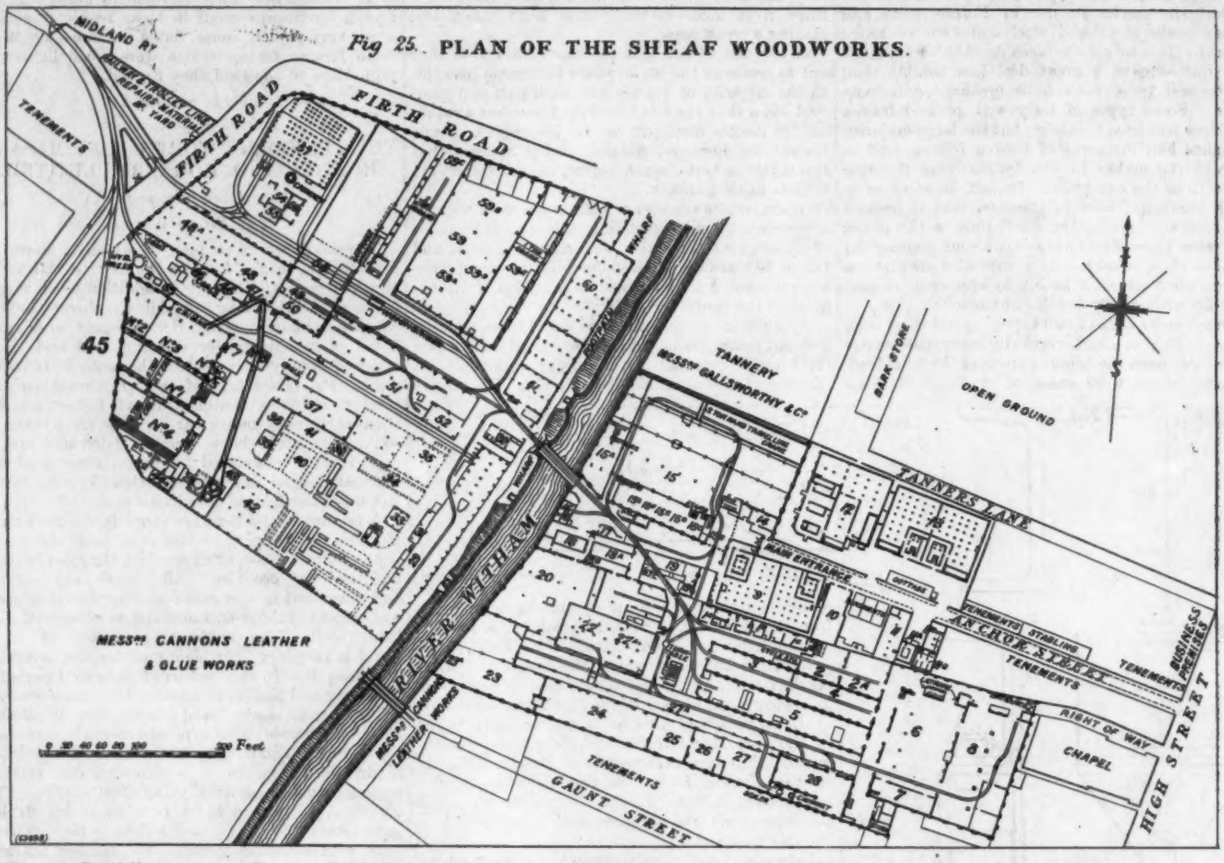
THE RUSTON NAVVY.

The Ruston navvy, which is so familiar a machine to all engineers who are concerned with excavating work on a large scale, is made in five standard sizes. These are known by numbers ranging from 5 to 30, the specific number allocated to a particular size denoting the upward pressure in tons which the cutting edge of the bucket is capable of exerting. The range of bucket sizes is from ¼ of a cubic yard in the smallest machine to 4 yards in the largest, and the general dimensions of each size of machine are proportional to its capacity, although special jibs are readily fitted when the spoil has to be delivered at an unusual distance from the machine, or when other considerations arise.

Fig. 29, on Plate VI, shows the general appearance of the smallest size of standard navvy, with the housing over the platform removed so that the machinery can be seen. Figs. 30 to 32 illustrate details of construction. The double width of wheels, shown in Fig. 31, enables the navvy to travel on either narrow or broad gauge tracks as may be required. This small model is specially adapted for such work as excavating clay for brickmaking, clearing sites or levelling ground for new buildings digging trenches, handling heaps of coal or gravel, or doing digging work generally. It will dig and dispose of 50 yards of sand or 30 yards of stiff clay per hour with two men on the platform and two on the ground, but one man in each place is sufficient for small outputs up to about 15 yards per hour. The weight of the machine is 16 tons. Besides its normal work of excavating, it can be used as a 4-ton travelling crane, or fitted with a grab bucket, while with slight modification it can be employed to dig trenches up to 10 ft. deep. It is sometimes fitted with caterpillar chain tracks, so that its mobility is increased and the labour of laying down rails for it is avoided.

The general construction of the machine is much like that of a locomotive crane. The upper platform can turn the full circle so that the bucket can dump into trucks on the rails behind it when desired. Every action of the machine is controlled by levers on the front of the platform and the position of the operator therefore is such that he has the best possible view of what is happening. The main engine, shown in the centre of the platform, has two cylinders, 5 in. diameter by 6 in. stroke with link

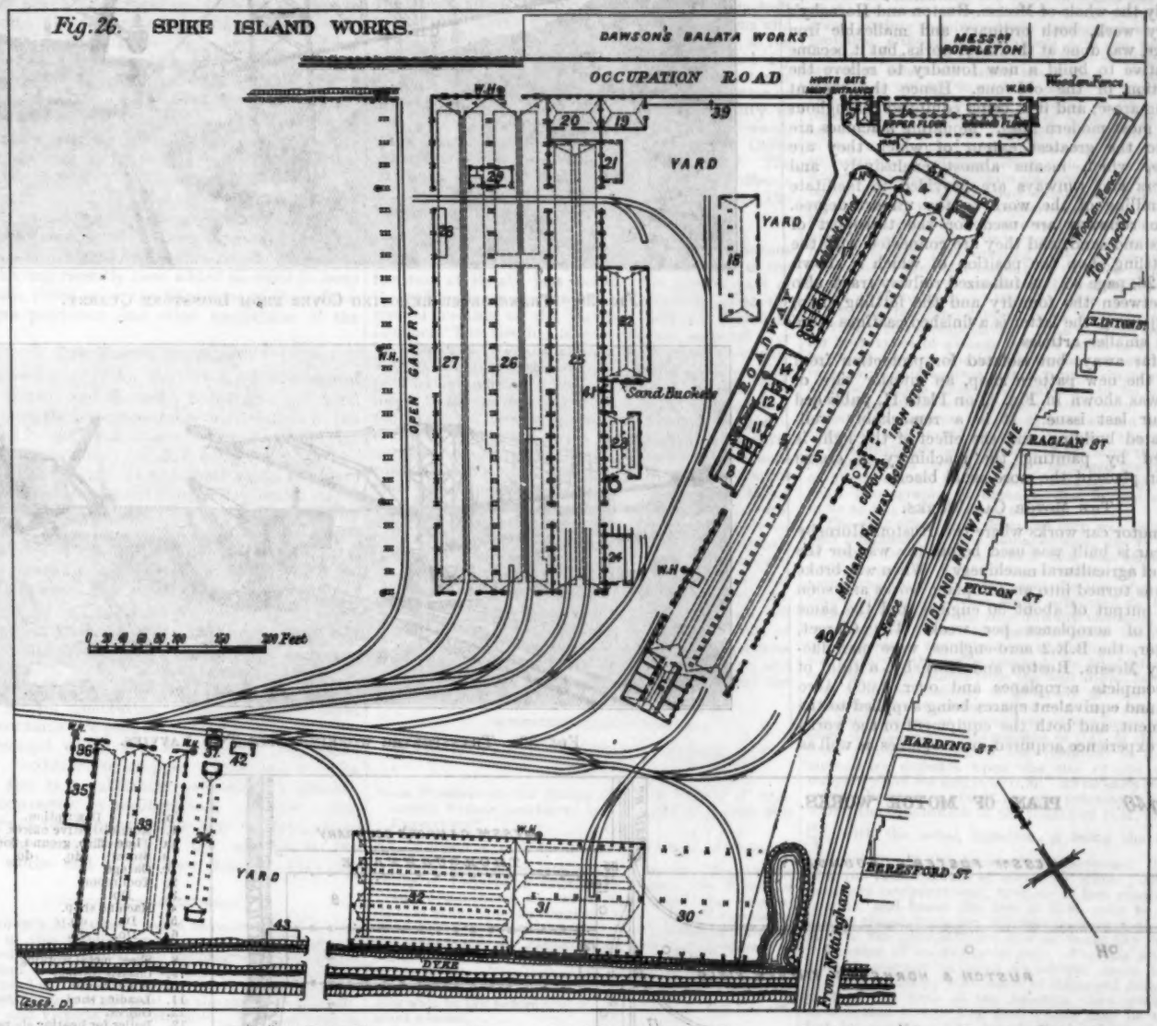
Fig 25. PLAN OF THE SHEAF WOODWORKS.



No.	Description.
1	Departmental offices, comprising—
1A	Head office
1B	Drawing office
1C	Photo copying
1D	General lavatory
1E	Ladies lavatory from D.O. landing
2	Hardwood drying store with gallery
2A	Hardwood drying store with gallery and racks
3	Upholsters shop for motor cars, with gallery
4	Do. do. do.
5	Paint dipping shop
6	Motor body framing department
7	Do. part stores
8	Do. panel department
9	General iron fittings for thrashers' store
10	Dining hall
11	General wood part fittings for thrashers' store
11A	Do. do. do.
11B	Do. do. do.
12	Store, various part fittings for thrashers
13	Army and navy stores, late malt kiln
14	Time and piece-work office
15	Fitting, turning and machine shop
15A	Gallery for turning and tool fitting
15B	Do. leather belt preparing
15C	Do. sheet metal working
15D	Do. General hardware, &c., stores
15E	Shops' drawing storage
15F	Tool drawing office
15G	Pump do.
15H	General stores under gallery No. 15B
16	Boiler house for heating shops
17	Ambulance room
18	Pump store
18A	General joinery for thrasher parts
18B	Gallery over for same purpose as 18A
19	Packing shop for extras
20	Thrasher framing shop
21	Boiler house for heating shops
22	Wheelwrights and woodworking machine shop
22A	General joinery shop above wheelwright shop
23	Thrasher erecting shop, 1st bay
24	Do. do. 2nd bay
25	Do. do. 3rd bay
26	Do. do. 4th bay
27	Do. do. 5th bay
28	Motor car woodworking machine shop
29	Smith shop
30	Cottage
31	Castings pickling shed
32	Pump house
33	Paint dipping shed for castings, &c.
34	Bar iron rack stores
35	Sheet and bar iron rack store
36	Bar iron rack
37	Electrical fitting shop
38	Show office, &c., store
39	Oil store
40	Groups of fixtures for castings
41	Groups of fixtures for stacks of castings
42	Sawn timber store
43	Saw mill refuge dump
44	Suction gas plant for power station
45	Power station comprising—
45	Engine room No. 1, condenser floor No. 1A
45	Compressor house No. 2
45	Boiler house No. 3
45	Engine room No. 4
45	Fan house No. 5
45	Babcock boiler house No. 6
45	Coal bunker No. 7, cyclone house No. 8
46	Electric repairs, &c., shop
47	Plumbers' shop
48	General Sawmill, 1st floor
48A	Storage room underneath for timber
49	Timber platform
50	Circular saw shed
51	General woodworking machine shop
52	Metal saw shops
53	Yard locomotive shed
54	Steam wagon shed
55	Woodworking tool grinding room
56	Saw sharpening shop
57	Timber drying kilns
58	Timber travelling crane over stacks
59	General purpose shop divided as follows :—
59A	Motor car chassis, painting and assembly department
59B	Painting department for motor car bodies
59C	Motor car varnish room
59D	General painting department
59E	Thrasher testing department
60	Prepared wood store, 1st floor Prepared iron parts store underneath
61	General packing case shop
62	Timber stacks
63	Do.
64	Do.
65	Water softening tanks
66	Do. do.

reversing gear, and provides power for hoisting or digging, travelling and slewing. The hoisting drum is driven by machine-cut gearing from the crankshaft through a steam-operated friction clutch embracing the end of the drum, and at the other end of the latter is a band brake by which the load may be lowered when the clutch is released. Besides the hoisting pinion the crankshaft of the engine also carries a pair of bevel wheels both gearing into another bevel wheel from which a vertical shaft descends. This shaft carries a pinion at its lower end gearing into a large ring bolted to the top of a spur wheel on the second motion shaft, which it drives at a much reduced speed. This shaft has keyed to it two small pinions which gear into racks fastened to the underside of the bucket arm. By raising or lowering the bucket by means of the main engine, the bucket arm is caused to swivel around the axis of the second motion shaft, so that the racking engine can do its work whatever the position of the bucket, and regardless of whether the latter is in motion or not. The racking engine is started, stopped and reversed by a single valve, as in the case of the steering engines of ships, so that it is size of navvy the corresponding standard dimensions are 33 ft. 6 in. and 43 ft. respectively. The appearance of a navvy at work excavating chalk is illustrated in Fig. 33, on Plate VI. The illustration shows the proportionate height of the cutting it makes, and alongside the machine can be seen an oil-driven Ruston locomotive removing the spoil. It is frequently necessary to shift the spoil to a considerable distance from the navvy, and in such cases a transporter is used in conjunction with the navvy. Figs. 38 and 39, on page 36, show transporters at work.

Fig. 26. SPIKE ISLAND WORKS.



No.	Description.	No.	Description.	No.	Description.	No.	Description.	No.	Description.
1.	1A. Canteen, 2 floors.	11.	Store.	20.	Navvy drawing office.	29.	Offices (W.D.O., W.O.O., Mr. Wattam's).	36.	Boiler house.
2.	Time office.	12.	Clerks' office.	21.	Latrines.	30.	Heavy casting store (open gantry).	37.	Weigh bridge and house.
3.	Telephone exchange.	13.	Mr. Feasy's office.	22.	Template shop.	31.	Fettling shop.	38.	Light foundry.
4.	4A. Core ovens and furnaces.	14.	Latrines.	23.		32.	Light casting store.	39.	Cycle shed.
5.	Machine moulding shop.	15.	Electric and compressor house.	24.	Boiler house.	33.	Pattern shop.	40.	Engine house.
6.	Sand mixing house.	16.	Ladies' rest room.	25.	Structural Shop (navvy's).	34.		41.	Acetylene. Gas house.
7.	Cupola house.	17.	Core shop.	26.	Erecting shop (do.).	35.	Latrines.	42.	Platelayers' store and workshop.
8.	Boiler house.	18.		27.	Machine shop (do.).			43.	Cycle shed.
9.	First aid room (gentlemen).	19.	Electric sub-power station.	28.	Offices (progress rate fix).				
10.	Do. (ladies).								

the undercarriage. By means of a sliding clutch, either bevel wheel may be made to rotate with the shaft and so to cause the slewing of the table in the corresponding direction. Another bevel wheel on the crankshaft drives, by means of a clutch, a vertical shaft passing down through the central pillar and this again drives a pair of sprocket wheels in the base of the machine from which the axles of the travelling wheels are driven by pitch chains.

Mounted on the jib is another steam engine called the racking engine, with two cylinders, 4 in. diameter by 5 in. stroke. The function of this engine is to move the excavating bucket to and from the jib. This it does by means of gearing which will be understood from the illustrations. The crankshaft of the engine carries a pinion which gears into under the most complete control of the driver, who only has to move a hand lever slightly in one direction or the other to bring about a corresponding movement of the bucket. The latter dumps its charge when the catch holding the hinged bottom of the bucket is released by a pull on the chain. The bottom door closes automatically by its own weight when the bucket is in its lowest position, the shaft about which the door hinges being arranged in such a position as to ensure this. The cutting teeth on the bucket are of manganese steel and are readily renewable by the removal of a couple of bolts. The cutting stroke of the bucket is from ground level to a height of 18 ft. 9 in. in this size of navvy, and the maximum radius of cut is 24 ft. from the centre of the track on which the navvy runs. In the largest

The general construction of a transporter for this purpose, is shown in elevation and plan in Figs. 34 to 37, on Plate VII. The receiving end is steadied by a rail which supports it as shown, and the bucket is started, stopped and dumped by a single operator standing at the base of the tower. A wire-rope drive from the operating platform actuates the motion of the bucket. A transporter of this type will handle material as fast as the navvy can dig and supply it, and by its means the material can be deposited at any distance up to about 100 ft. from the point at which the navvy delivers it.

The illustration, Fig. 38, page 36, shows the navvy removing the top cover of an ironstone quarry, the transporter dumping this material on the far side of the working face of the quarry. The other

view, Fig. 39, shows two navvies, the one on the upper level removing the top cover which is carried away by the transporter, and the lower one excavating the ironstone itself which it loads into railway trucks. The transporter is so constructed that the arm on one side of the tower can be raised to permit the passage of the quarrying navvy beneath it. The illustration shows this navvy in the act of passing.

The New Foundry and Pattern Shop.

Adjoining the navvy works is the new foundry, which has a floor area of 60,000 sq. ft. Until recently the whole of Messrs. Ruston and Hornsby's foundry work, both ordinary and malleable iron castings, was done at the Sheaf works, but it became imperative to build a new foundry to relieve the congestion of the old one. Hence the present building arose, and it is being equipped throughout on the most modern lines. Moulding machines are used to the greatest extent of which they are capable, which means almost exclusively, and travellers and runways are provided to facilitate the handling of the work to the utmost degree. Electric runways are used for the transport of castings and sand, and they are connected with the new fettling shop the position of which is shown on Fig 26, page 35. A full-sized railway track also runs between the foundry and the fettling shop, and adjoining the latter is a finished castings store for the smaller articles.

Not far away, but isolated for protection from fire, is the new pattern shop, an interior view of which was shown in Fig. 5, on Plate II, published with our last issue. It is a remarkably well-illuminated building, and the effect of the light is increased by painting the machinery a cream colour in place of the more usual black.

The Motor Car Works.

The motor car works where the Ruston Hornsby motor car is built was used before the war for the storage of agricultural machinery. When war broke out it was turned into an aeroplane works and soon had an output of about 30 engines and the same number of aeroplanes per week. The Clerget, and, later, the B.R.2 aero-engines, were manufactured by Messrs. Ruston and Hornsby, a total of 2,750 complete aeroplanes and over 4,000 Aero engines and equivalent spares being supplied to the Government, and both the equipment of the works and the experience acquired in aeroplanes as well as engine manufacture indicated the production of motor cars as a suitable sequel to their war-time activities. It need hardly be said that the same methods of quantity production and rigid standardisation which were employed on aeroplane work have been applied to the manufacture of the Ruston Hornsby car. The plan of the motor car works is shown in Fig. 40. The area of the machine shops alone is 47,700 sq. ft., and the tool-room covers an additional 10,800 sq. ft. The whole of the shops are spacious and excellently lighted. Fig. 41, on Plate VIII, shows the interior of the erecting shop, and Fig. 42 gives a view of the machine shop. The cars start at the far end and progress steadily down the erecting shop on their own wheels, being completely fitted and ready for the test beds as they arrive at the exit. The capacity of the works is about 100 cars per week, the present output being about half this and rising rapidly. The mess-room at these works can seat 1,000 employees at a single sitting.

Fig. 38. Transporter removing Cover from Ironstone Quarry.

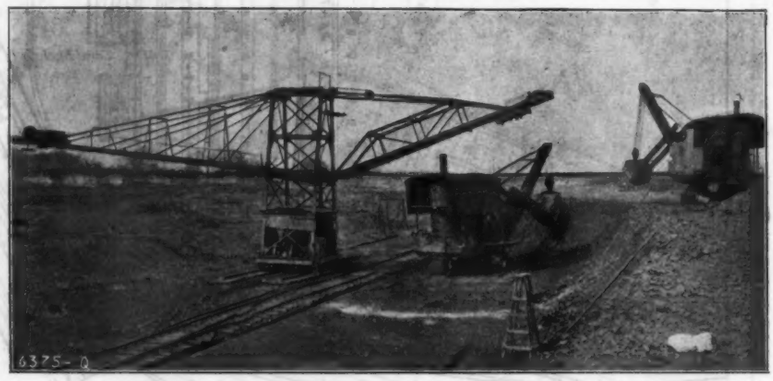
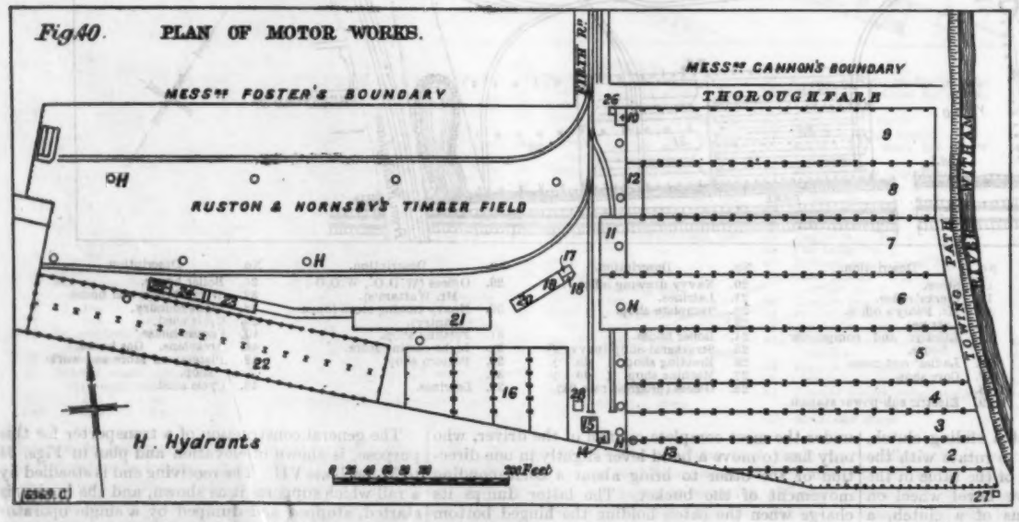


Fig. 39. Transporter working with Two Navvies.



No.	Description.
1.	Administrative offices.
1A	Time office, ground floor.
1B.	Stores do. do.
1C.	Garage.
2.	Tool room.
3.	Do.
4.	Machine shop.
5.	Do. do.
6.	Do. do.
7.	Do. do.
8.	Sheet metal working.
9.	Chassis testing.
10.	Boiler house.
11.	Loading shed.
12.	Offices.
13.	Boiler for heating shops 1–9.
14.	Do. do. canteen.
15.	Ambulance.
16.	Canteen.
17.	Fire station.
18.	Sub-station electric.
19.	Accumulator charging.
20.	Sud mixing.
21.	Heat treatment.
22.	Chassis erecting.
23.	Lavatories.
24.	Stores.
25.	Boiler house for heating No. 22.
26.	Watchman's hut.
27.	Do.
28.	Petrol stores.

The Ruston Hornsby Car.

The Ruston Hornsby car is made in one model only, a five-seater 16/20 h.p. touring car rated at 15·9 h.p. The engines have four cylinders, 80 mm. bore by 130 mm. stroke and develop 35 brake horse-power. The cylinders are cast in one with the top half of the crank-case, and the cylinder head is a detachable casting. The gear-box and rear axle are built as a single unit. The gear provides for three speeds forward and a reverse, with a direct drive on the highest speed. The bevel gear reduction in the back axle is 4¼ to 1. The wheel base of the car is 9 ft. 9 in. and the width of track is 4 ft. 8 in. The ground clearance is 9 in. A high-tension magneto provides for ignition and the other electric equipment comprises a C.A.V. lighting plant, an electric starter of the same make, and an electric horn operated from the steering handle. Framing, axles and body work are all manufactured by

Messrs. Ruston and Hornsby in Lincoln, and their laboratories, already referred to, keep a constant check upon the quality and uniformity of all materials used.

THE TESTING LABORATORIES.

Exceptionally well equipped chemical and physical laboratories exist at the Sheaf works, and these are not, as in many cases, an innovation due to war experience, but have for many years been a feature of the works. The equipment comprises Buckton tensile, Izod impact and Brinell hardness testing machines also a diaphragm machine for transverse beam tests. In the metallographical room micro-photographic work is continuously in progress either as the routine examination of heat-treated material or the physical structure of alloys, or in order to investigate special problems in metallurgy. Similarly the well-equipped chemical laboratory is continuously engaged in the analysis of materials used in the works, determinations of the carbon and other contents of steels, &c. Everything necessary in the way of apparatus for elucidating the problems of the works appears to have been provided, the latest type of Orsat apparatus for gas analysis and different types of recording gas calorimeters having recently been added in order to keep a scientific check upon the behaviour of the refuse-using gas producers and other specialities of the firm.

THE POWER STATIONS.

The power supply for the five Lincoln works of Messrs. Ruston and Hornsby, Limited, is generated at two separate power stations, one situated in the Sheaf works and the other at the Wood works. An additional supply is also obtained from the Lincoln Corporation. In the Sheaf works there are four horizontal slow-speed Ruston drop-valve steam engines, two of 1,000 brake horse-power and two of 500 brake horse-power. These are fitted with condensers, and are direct coupled to continuous-current generators supplying current at 500 volts. The boilers providing them with steam are fitted with Bennis mechanical stokers. A sub-station adjoining, contains a 500-kw. rotary converter with the necessary transformers, which converts the 3,000-volt, three-phase alternating supply of the corporation, into direct current at 500 volts.

The second generating station, in the wood works, contains five prime movers aggregating 2,100 kw., amongst which is a four-cylinder horizontal Ruston producer-gas engine. Attached to this station also is a substation containing a 500-kw. rotary converter, in addition to a 1,000-kw. static transformer for supplying low tension three-phase alternating current power to the machines in the Navvy works and in the new foundry adjoining them.

"YARROW'S MAGAZINE."—We have received the first number of this publication, a quarto of 30 pages of illustrated matter dealing with the progress and activities of the firm. The visit of the Prince of Wales to the Yarrow yard at Victoria, British Columbia, is described. Other articles are of interest to the staffs of both the Glasgow and Victoria establishments. The magazine is nicely got up in every respect.

BREAKAGE OF LOCOMOTIVE CYLINDERS.—The breakage of cylinders on locomotives is among the troubles which have increased with the introduction of large engines, says *The Railway Mechanical Engineer*, New York. The universal use of piston valves may be partly responsible for this trouble, or it may be due in part to the proportionately smaller clearance volume on large cylinders. The major share of the blame, however, may be ascribed to improper cylinder cock rigging. Little attention is paid to the maintenance of these parts; the long connecting pipes are often not properly supported, and if there is more than the usual amount of resistance to the movement of the lever, the connecting rods buckle or the levers bend, with the result that the cylinder cocks do not open. The inevitable result is frequent breakage of valve and cylinder packing rings, if the cylinder itself is not fractured. Several devices are now in use which operate the cylinder cocks either by compressed air or by action of the pressure within the cylinder. It would seem that a more general application of such devices would be justified in cases where difficulty is experienced in applying a satisfactory design of manually operated cylinder cock rigging. It must be realised that such changes are open to objection on the basis that they introduce additional complication on the locomotive, but the cost of new cylinders or of welding broken cylinders, together with the loss of service from the locomotive, is so serious that there should be no question as to the desirability of using such devices where excessive cylinder breakage is experienced.

NOTES ON NEW BOOKS.

A BOOK which gives the names of the shipowners of the world, the addresses of their various offices, the names, tonnage and speed of the ships forming their fleet, the date of building, the names of the builders of the hull and of the engines, the lines served, &c., forms a useful guide for merchants and traders. Such a book is the "*Directory of Shipowners, Shipbuilders and Marine Engineers*, 1920," which is compiled under the direction of the Editor of *Shipbuilding and Shipping Record*, and is issued by the Directory Publishing Company, Limited, Queen Anne's Chambers, Westminster, S.W. 1. Besides shipping, which is dealt with alphabetically under the names of the firms and under the ships' names, a special chapter covers, as the title implies, shipbuilders, marine engineers and dry dock owners. This will prove of particular interest to firms who are in the market for ship construction or ship repairing; this chapter gives the capacity of each yard and works, the number of berths owned, the dry docks and the dimensions of the latter. Other indexes facilitate reference to the directory. The publishers state that the names of over 8,000 officials and 7,000 vessels are contained in the indexes. The book is carefully got up and is clearly printed.

A valuable addition to the literature on non-ferrous metals is the twenty-third volume of the Journal of the Institute of Metals, just issued. The greater part of the volume is an account of the proceedings at the general meeting of the Institute held last March in London. The meeting in question was presided over by Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D., and the volume contains his interesting presidential address. This is followed by the fifth report to the Corrosion Committee of the Institute and the discussion thereon, a record of work which appeals to marine and mechanical engineers, and will greatly aid them to overcome the vexed corrosion problems with which they are confronted. The other papers read and discussed at the same meeting and relating to a number of different alloys, their manufacture, tests, characteristics and uses, are also reproduced in the volume, which closes with abstracts of journals concerned with non-ferrous metals and the industries connected therewith. The volume, with index, has close upon 650 pages and its price is 31*s.* 6*d.* net. It can be obtained at the offices of the Institute, 36, Victoria-street, S.W. 1. We take this opportunity of congratulating the Institute upon the great progress it has made since its formation, twelve years ago, and upon its activities which have greatly benefited the industries concerned.

WAR EXPERIENCE WITH MERCHANT SHIPS.

*Some Features in the Design and Construction of Mercantile Vessels considered in the Light of Recent War Experience.**

By Professor J. J. WELCH, D.Sc. (Member of Council).

WHEN, during the late war, the enemy adopted the policy of torpedoing mercantile vessels, the Board of Trade commenced an investigation into the circumstances attending the damage or loss of such vessels by mine or torpedo, with a view to determining whether the experience so gained suggested modifications of design or details which would conduce to greater safety of life at sea. The author was asked to undertake this investigation, and some of the information gained he is now able to lay before you by permission of the Department named.

Reports from captains and other officers, detailing what occurred at the time of the casualty and afterwards, were received for a very large number of ships, these reports being supplemented later by answers to a *questionnaire* sent out by the Board of Trade to any on board at the time who could throw any light on the subject. These questions, being directed to specific points, were the means of adding materially to our knowledge, and a copy of this *questionnaire* is given in the appendix. Further, in a large number of cases information was obtained from owners giving particulars of form of ship, disposition of bulkheads, freeboard, metacentric height, &c., thus enabling a detailed analysis to be made in such cases. Naturally enough, the circumstances in which the vessel was attacked, and the urgent necessity for taking to the boats, often made impossible detailed observations as to the exact effect of a blow; but from the mass of information available it is possible to arrive at some general conclusions as to sub-division, and to suggest modifications as to details.

One point brought out by this analysis is the reasonableness of the figures for permeability suggested by the 1914 Bulkhead Committee. Thus in nearly every case, when analysis, based on these permeabilities, showed that a vessel damaged in machinery or cargo spaces should float or sink, the analysis was confirmed by experience. Moreover, when analysis in connection with general cargo spaces showed that the vessel should have just floated, or should just sink, the actual results have been in accord. In other cases of damage to cargo holds, analysis, based on 60 per cent. permeability, showed that the vessel should have sunk, whereas in fact she remained afloat: in such cases, however, the cargo was not of a "mixed" or general character, but of homogeneous nature such as grain, which is known to have a lower permeability than 60 per cent., and the discrepancy mentioned was thus adequately accounted for.

Before proceeding further, it may be interesting to give some account of the nature and extent of damage caused by torpedo or mine. When a vessel is struck in way of a cargo hold, the hatches are usually blown off, and as the hatchways are of considerable size the relief of the pressure set up by the explosion must be very great, tending to minimise the damage below. It seems probable, although the evidence does not justify dogmatism, that as the hatchways in large and fast steamers are often relatively small, the pressure would not be relieved so quickly in such vessels as in others, and increased damage below and to decks, as compared with purely cargo vessels, is likely to result. The irregular holes blown in the side or bottom plating varied greatly in size, and, in cases where holds were empty, or nearly so, splinters of plating, rivets, &c., were likely to be driven through the opposite side and the boundary bulkheads of the compartment attacked. Pump suction pipes leading to other compartments have often been fractured, and pipe, communication, and shaft tunnels passing through mined or torpedoed compartments have been damaged, thus opening other spaces to the sea. The sizes of the holes made by a torpedo varied, in the vessels which have subsequently reached port, from about 40 ft. by 23 ft. to 16 ft. by 14 ft., the corresponding figures for mine damage being 43 ft. by 21 ft. and 13 ft. by 10 ft. respectively. The average size of hole for both types of damage may be taken as about 30 ft. by 20 ft. From this it follows that to make a vessel reasonably safe against attack from a single torpedo or after striking a mine, the ship should be capable of remaining afloat with any two holds open to the sea, whilst the minimum length of hold should be not less than say 40 ft. to 45 ft., so as to avoid the possibility of two bulkheads being injured at the same time. These conditions can be conveniently arranged for in a vessel of about 450 ft. to 500 ft. in length. Figs. 1 and 2 show photographs of damage, due in one case to a mine and in the other to a torpedo.

The first effect on a damaged ship was to produce a heel temporarily to the damaged side, due to the influx of water on that side, which heel was eliminated or reduced as the water became uniformly distributed across the ship. In some cases the loss of metacentric height due to the loose water admitted to holds was sufficient to render the ship initially unstable, and heeling resulted from this cause; such heeling being diminished, or the ship even regaining the upright, as the water in the holds reached the level of the water outside. This follows from the well known fact that the loss of initial stability is generally greatest when the quantity of water admitted is relatively small. Treating the question as one of loss of buoyancy, with constant displacement, the position of C.G. of ship remains fixed throughout, whilst the variation in location of metacentre depends upon the rise of the centre of buoyancy and the length of B.M. At an early stage of the inflow, the position of C.B. remains practically unaffected, whilst the diminution in the length of B.M. is given by $\frac{\mu i}{V}$ with the usual notation, μ being the fractional permeability of the damaged compartment. The value of i, the total amount of inertia of water plane area in damaged compartments, is more or less constant at all heights, and hence the loss of G.M. may be considerable in the early stages, and less important as the water rises in the compartment and so raises the position of the centre of buoyancy of ship. For this reason it is more important to have watertight doors low down in the containing bulkheads of damaged compartment shut at the time of the casualty than similar doors at a higher level. The final result may be the same, but by confining the longitudinal extent of the free water low down, the ship may continue upright, and if the ship has ultimately to be abandoned the upright position will facilitate the getting away of the boats and so conduce to the saving of life.

Out of the total number of cases examined, only some six or seven were stated to have capsized, although these included some important vessels; and of these, one was attacked by torpedoes, shells and bombs, whilst another was hit by two torpedoes. A fairly large number of ships are said to have retained a list, either "slight" or "heavy" after damage, most of these being in a "light" or lightly-laden condition. In the large majority of cases, however, there is no hint of permanent list, and the vessels regained the upright after damage. As to the possibility of listing in the "light" condition, it will be remembered that many vessels of relatively fine form have very moderate metacentric heights in that condition, so that the loss of stability due to the inflow of water, mentioned above, might well suffice to give a negative G.M. with consequent heeling; in one case, indeed, the loss of stability due to this cause was so great as to result in the capsizing of the vessel. On the other hand, vessels of full form, carrying their breadth well down, often have very large metacentric heights when light, and many such vessels in this condition have continued to float upright with two or more large compartments flooded.

Generally, of course, after damage the mean draught of a vessel is considerably increased, but in the case of laden oil-carriers the vessels remain at about the same draught as before, if struck in way of the tanks. In such vessels the machinery space is usually aft, and if

* Paper read before the Institution of Naval Architects, July 6, 1920.

the engines and boilers are in one compartment a laden vessel is likely to sink if struck aft. This points to the desirability of fitting a watertight bulkhead between engines and boilers in these otherwise well-subdivided vessels.

To indicate the subsequent behaviour of ships after being torpedoed or mined, under the actual conditions prevailing at the time, details are given below for a number of representative cases, after which it will be possible to formulate some general conclusions.

1. This liner, 500 ft. in length, was torpedoed without warning, and she capsized and sank in five minutes, the engines going ahead to the last. The torpedo struck on the port side, probably at the cross-bunker between the two boiler-rooms, thus opening up two main compartments to the sea. The combined space so opened up had a length constituting about 20 per cent. of that of the ship, but calculations show that under the conditions of the ship's lading nearly 30 per cent. of the ship's length could have been opened up in this region without the vessel sinking. The evidence, however, showed that the watertight door giving communication between engine and boiler rooms was open—the second engineer thought of attempting to close it, but had no time—and large quantities of water were seen in the engine room. It was also given in evidence that many sidelights below the bulkhead deck were open at the time for ventilation purposes. With such an extensive range of compartments open to the sea, the loss of stability would be serious, and the consequent listing would put open ports under water, thus making capsizing inevitable.

2. In the case of this passenger vessel, 550 ft. in length, the torpedo struck without warning about 100 ft. from the stern, and the vessel listed and settled down aft, finally capsizing and sinking 25 minutes after being hit. An explosion at the point indicated would damage the transverse bulkhead dividing two holds immediately abaft the engine room, the length of these holds being 24½ per cent. of the length of ship. As this was somewhat greater than the floodable length under the probable conditions of lading at the time, ultimate foundering was likely. The evidence showed that water in large quantities found its way into the engine room, indicating that the starboard shaft tunnel had been damaged and that the tunnel door was open. This extension of flooded area would materially affect the stability adversely, and shorten the time the vessel remained afloat.

3. This very important passenger vessel, 850 ft. in length, when in use as a hospital ship, either struck a mine, or was torpedoed without warning, and sank by the head 55 minutes afterwards, listing heavily to starboard. The blow took effect on the starboard side forward, in way of the bulkhead dividing Nos. 2 and 3 holds, damaging also the watertight tunnel (for firemen and pipes) leading at the middle line through these holds. This tunnel terminated forward on the bulkhead at the after end of No. 1 hold, and that hold was also flooded, the reporting officers surmising that the after bulkhead of No. 1 had been injured by the explosion; it is possible, too, that suction pipes to No. 1 had been damaged. Had only the compartments mentioned been open to the sea the vessel would have been perfectly safe and under control. Unfortunately, however, the watertight door between No. 3 hold and No. 6 boiler room and that between Nos. 6 and 5 boiler rooms remained open, there being some evidence that the last-named may have been partly closed; whilst side scuttles below bulkhead deck were also open, notwithstanding the fact that orders had been given that these should be kept closed. Under these circumstances a length of the ship totalling about 250 ft., and including the two foremost boiler rooms, was invaded by the sea, and these compartments rapidly filled, the vessel speedily heeling to an angle of about 25 deg. This, in association with the trim by the head, immersed open side ports and water gained access to other compartments, including No. 1 boiler-room, into which water flowed from open ports in the adjacent galley. It will be seen that the loss of this vessel was primarily due to the fact that the two watertight doors already mentioned remained open, the sinking being accentuated by the open side scuttles. These doors were of drop type, and were intended to be automatically released by bilge floats; they could also be independently closed from the door positions and by means of gearing leading to the upper deck. It is probable that the force of the explosion distorted the bulkhead between No. 3 hold and No. 6 boiler room, so preventing the closing of the door; but this is not likely to have affected the door at the fore end of No. 5 boiler room, and the failure to close this door from the deck may possibly have been due to an obstruction in the opening, washed there by the inrush of water. The other doors were effectively closed after the casualty, as no water got abaft No. 5 boiler room through openings low down in the hold.

4. When employed as a hospital ship, and in a light condition, this vessel, 500 ft. in length, was torpedoed at night on the port side, and disappeared in about 10 minutes, sinking by the stern with little or no heel. She first heeled to port, then heavily to starboard, and finally gained the upright. The torpedo struck toward the fore end of No. 4 hold (70 ft. in length), opening up also the engine room immediately before it. The captain thought that the after bulkhead of No. 4 was also shattered by the explosion, but this seems doubtful in view of the length of the compartment, although it might have been pierced by splinters. Unfortunately all the engineers were lost, and no reliable evidence was forthcoming as to whether watertight doors between engine and boiler rooms, and other doors, were open or closed; the captain stated that his standing orders were that all watertight doors were to be kept shut at all times except where actually necessary for the working of the ship. With No. 4 hold and engine-room only open to the sea the vessel in her light condition would easily have remained afloat; and the fact that she sank so quickly indicates that water obtained access to other compartments, through sidelights (which were open) and/or through open doors, or in consequence of the after bulkhead of No. 4 having been shattered as suggested by the captain.

5. In the case of this passenger vessel, 600 ft. in length, the torpedo took effect on the starboard side, and resulted in the vessel sinking, stern first, in about 10 minutes with practically no heel. The vessel was struck in way of No. 5 hold—that immediately abaft engine-room—and towards its after end, thus opening up No. 6 hold also, so that some 22 per cent. of the vessel's length was in communication with the sea. This is about the floodable length under the probable conditions of lading at the time, and the vessel might just have remained afloat had no other circumstances supervened. The captain states that all watertight doors were kept closed which possibly could be, including the tunnel doors; and all lower deck ports were also closed and secured. This vessel, however, had passenger accommodation on the middle deck (below bulkhead deck) with hinged watertight doors on divisional bulkheads for communication; and if, as appears from the evidence, these were open, or if sidelights in these passenger spaces were open, the rapid sinking by the stern and ultimate foundering would be accounted for. The junior fifth engineer left the engine room through the watertight door at the middle deck, and met the water as he went aft, so water would ultimately be free to pour into the engine room from above. It may be pointed out that the captain's precaution in having the tunnel doors closed during the voyage was most probably instrumental in saving the lives of many on board. The blow occurring where it did, the starboard shaft tunnel would almost certainly be damaged, but the closed door prevented the spread of water into the engine room low down; this in turn prevented undue loss of metacentric height, so that the vessel remained upright after damage, and the task of getting away the boats rendered much easier. Hence, in spite of the limited time available, 390 persons were saved out a total of 429. Had the vessel been subdivided aft in accordance with the 1915 Bulkhead Committee's recommendations, the bulkheads bounding the two spaces breached would have been closer together than in the actual vessel; and with bulkheads so spaced the ship would have undoubtedly remained afloat and all watertight doors and sidelights been effectively closed.

6. The torpedo by which this twin-screw vessel, 526 in length, was attacked, took effect on the port side about 8ft. forward of the sternpost. The stern-frame, rudder-post and rudder were blown away, propeller shafts were bent, and the after tunnel recess opened up to the sea. The vessel listed heavily to port, but kept afloat. The starboard tunnel door (closing horizontally) was satisfactorily shut after the casualty, but the closing edge of the port door fouled the frame, due, the surveyor thought, to the explosion 130 ft. away buckling the bulkhead. Considerable quantities of water thus got into the machinery compartment, and, as the bilge injection suction was on the starboard side, it could not be used in consequence of the heel of the vessel. Other pumps were, however, available, and were sufficient to deal with the inflow.

7. This single-screw vessel, 552 ft. in length, struck a mine, which opened up a hole about 29 ft. by 20 ft. in. her port side, thus putting holds No. 2 and 3 in communication with the sea. The vessel remained afloat without sensible heel. The combined length of the holds named was 86·3 ft., and with the freeboard ratio obtaining at the time, and with the water confined to the damaged compartments, the ship should easily keep afloat, as she did. One interesting circumstance reported is that the suction pipe from No. 2 to No. 1 hold was fractured by the explosion, but no water passed into No. 1 because the explosion had effectively flattened the pipe-end; similarly, the pipe to the fore peak was cut by a falling stanchion, but was closed, forward of the cut, by another falling stanchion.

8. This liner, 550 ft. in length, was torpedoed on the starboard side in the vicinity of the after engine room bulkhead when in fairly light condition. The bulkhead named was damaged, so that No. 5 hold and the engine room were flooded. The chief officer found the engine room full of water and the boiler room (probably rooms) flooded. At the time of the casualty the two tunnel doors were open, as were also the communication doors between engine room and after boiler room, and those between boiler rooms, so that all the machinery spaces would speedily be in communication with the sea. In addition, the watertight doors in the upper parts of the bulkheads at the after ends of Nos. 5 and 6 holds were open, so that No. 6 hold and the after peak would also be flooded. In these circumstances it is somewhat surprising that the vessel remained afloat for an hour and 23 minutes, ultimately sinking by the stern. She remained upright athwartships until the last few moments, when she heeled 15 deg. to port—due, it is thought, to the keel taking the ground—and then regained the upright before sinking.

FIG. 1. DAMAGED BY MINE.

9. This liner, 570 ft. in length, collided with an escorting destroyer, detaching depth charges which exploded in the water. A hole 52 ft. long was made in No. 1 hold near the bottom, the bulkhead between Nos. 1 and 2 holds being damaged, so that both holds were immediately flooded. The fore peak also filled, possibly through a damaged suction pipe. The bulkhead at the after end of No. 2 remained tight, but water was observed to rise slowly in the cross-bunker immediately abaft this bulkhead, and in the forward boiler-room. This was due to suction pipes from forward double-bottom tanks being fractured in the forward stokehold by the explosion, and water passed through the fractures into the stokehold and adjacent coal bunker. The water in stokehold submerged open valves which required to be closed in order that pumps might be made available for clearing this water, and it was not possible therefore to keep this water under. Fortunately all watertight doors in the lower part of the vessel, and all side scuttles, were closed before the accident, so that, in particular, water was not free to pass by the lower watertight door between No. 2 and the forward stokehold. Leakage occurred at the sills of some of the doors, due to wear by coaling barrows; and water entered the ship from without through drain pipes from between deck accommodation, this being attributed to the deterioration of the valve rubber With this gradual entry of water into spaces not imme-

diately affected by the accident, foundering was inevitable, and the ship was beached seven hours after the casualty (her forefoot grounding in 7 fathoms of water) in an apparently sinking condition.

10. This ship, 410 ft. long, was torpedoed, when light, on the starboard side in way of No. 3 hold, this being abaft a deep tank which was immediately abaft the engine-room. The size of hole made was 36 ft. by 25 ft., and the ship, with a slight list to port, was beached one and three-quarter hours after the casualty. No. 3 hold and the deep tank were opened to the sea; the shaft tunnel was blown in for a length of 35 ft., and the shaft gland at the fore end of tunnel was damaged and forced out, the tunnel door being open. Thus water at once entered the combined engine and boiler space, and thence passed, through two open watertight doors, into the non-watertight cross bunker, and so into No. 2 hold; from this compartment water penetrated to No. 1 hold through a broken suction pipe. This pipe was found broken in No. 2 hold, due, it was conjectured, to the force of the explosion 140 ft. away. Later investigations, however, led to the conclusion that this pipe had been broken earlier in consequence of fatigue due to vibration stresses. Had the tunnel door been closed, serious leakage would still have taken place past the

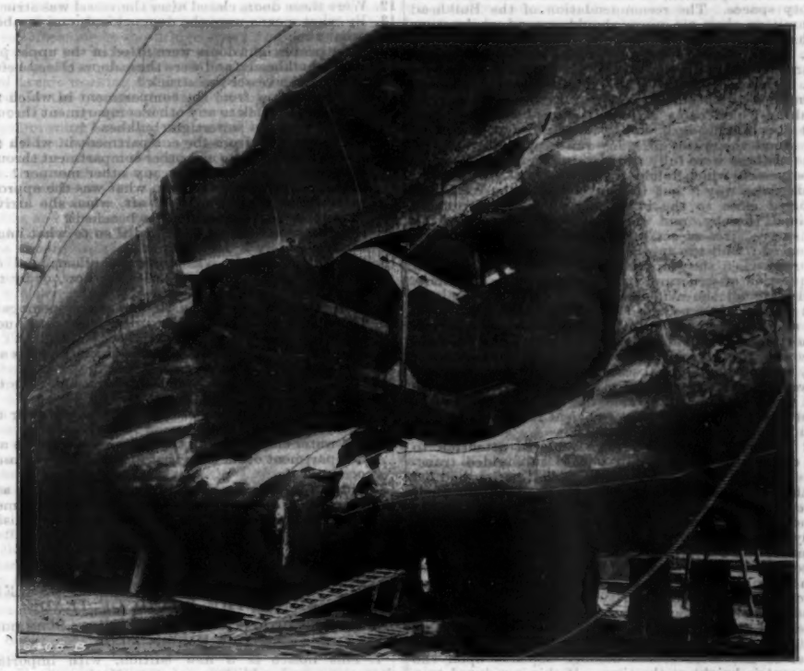


FIG. 2. DAMAGED BY TORPEDO.

shaft gland; but even if the machinery space had been filled, the vessel in its light condition would certainly have remained afloat. As, however, the door at forward end of machinery space were also open, leading to No. 2 hold (102 ft. in length), and leakages were taking place into No. 1, it was obviously necessary to beach the vessel. After the vessel was put aground the tunnel door was lowered, but could not be completely closed, because a wire rope, used as a handrail in the tunnel, had been blown partly through the door.

11. The circumstances attending the loss of this vessel, 375 ft. long, are interesting because airtight hatches had been specially fitted at the upper deck, all hold and 'tween deck ventilators had been air-locked and other arrangements adopted for securing airtightness, with a view to preserving flotability as much as possible. When laden with coal this vessel was torpedoed on the port side in the vicinity of the fore peak bulkhead, and sank without heel after remaining afloat for three days. The foundering occurred after the vessel had been towed stern first about 20 miles, in fine weather. The combined length of No. 1 hold and fore peak constituted about 24 per cent. of the vessel's length, whilst, taking the real permeability of coal at 40 per cent., the floodable length at the fore end was 33 per cent. of the ship's length; thus the vessel should have continued to float without any reliance on airtight work. The fact that she ultimately foundered indicates that water found its way to other compartments, and the superintending engineer forwarded a sketch, based on an interview with the captain, showing No. 2 hold flooded, although it is not known how this information was obtained for this airtight compartment. The seat of the explosion was some 60 ft. from the forward bulkhead of No. 2 and damage to that bulkhead was therefore unlikely, unless, indeed, the airtightness of the hold confined the explosion effect and so led to the disturbance of the watertightness of the bulkhead. The airtightness of No. 1 hatch was certainly affected, for the chief engineer heard air issuing from that hatch and noticed that the deck on the port side of the hatch was slightly buckled. If water obtained access to No. 2, a length of compartments totalling nearly 50 per cent of the ship's length would be open to the sea, and final loss was certain. The water would, however, percolate slowly into No. 2, in virtue of the latter's airtight condition, and would thus delay the sinking of the vessel. To this extent airtightness was an advantage; but, on the other hand, if the conjecture as to the cause of the disturbance of the watertightness of the bulkhead at the fore end of No. 2 is correct, the vessel might have remained afloat had the force of the explosion been free to take effect through ordinary non-airtight hatches.

12. This ship, 389 ft. long, was torpedoed, when laden, on the port side, a breach being made about 17 ft. by 15 ft. The vessel remained afloat until beached 16 hours afterwards. She at first heeled 30 deg. to port, recovered herself after about half an hour, and then went 7 deg. to starboard, at which angle she remained until put ashore. The blow took effect in No. 2 hold, about 25 ft. from the fore end, damaging the suction pipe to No. 1, so that the last-named had about 14 ft. of water in it when the vessel was beached. The bulkhead at the fore end of No. 2 was distorted by the explosion, stiffeners, girders and rivets being broken, and so water entered No. 1 by this means also. Further, the bulkhead at the after end of No. 2 was bulged, due, the second officer considered, to the swelling of nuts, peas, &c., composing the cagro of this hold; thus a relatively small amount of water found its way into the machinery space. The length of No. 2 constituted 25 per cent. of the length of the vessel, and with this alone opened to the sea the safety of the ship would be in jeopardy; with No. 1 also partly filled the vessel was evidently in a sinking condition when beached.

13. This cargo vessel, 428 ft. long, was torpedoed when light, abreast No. 5 hatch, opening up a compartment 95 ft. in length, and causing her to capsize within 5 or 6 minutes. Floating light, the reserve buoyancy should have amply sufficed to keep her afloat, and the fact that she capsized indicates that in the light condition she had moderate metacentric height only (no particulars of stability were known by builders), and the serious loss of stability due to free water was sufficient to cause not only severe listing but actual capsizing of the vessel. Nothing is said as to whether the shaft tunnel was damaged, and tunnel door open, but if this was so, the danger of capsizing would be correspondingly increased.

14. In this case the vessel, 500 ft. long, when floating at about 8¼ ft. less than her load draught, was torpedoed on the port side in No. 4 hold, a compartment 82½ ft. in length, situated immediately abaft the engine room. The resulting hole was 36 ft. by 20 ft., the port shaft tunnel was blown in, and the bulkhead between Nos. 4 and 5 holds buckled. The tunnel doors were closed before the casualty and remained uninjured, but the stuffing gland on the port shaft at the fore end of the tunnel was blown out in fragments. Water was thus free to enter the engine room and also found its way into No. 5 hold through the damaged bulkhead mentioned. The watertight door between engine and boiler room was closed about half an hour after the casualty, when the water was about 3 ft. above the tank top; this door, however, was not fully effective, as it jammed on a piece of canvas, so water continued to flow by this means into the boiler room, although not in any serious quantity. The boiler room finally filled from the engine room through the main steam pipe connections in the dividing bulkhead. These connections were bedded on lead pad pieces, but these were not well fitted, and hence the leakage. There is a watertight passageway leading from the boiler room through the bunker to No. 3 hold, the W.T. door to this having been shut before the casualty; but in way of this passage the bulkhead stiffeners had been cut short and were without brackets, in consequence of which the water pressure buckled the plating and broke rivets in the vicinity, so that water entered No. 3 hold. The vessel was ultimately beached. She listed 8 deg. to port shortly after being torpedoed, but afterwards regained the upright position.

15. This oil carrier, 420 ft. long, had on board 8,700 tons of oil in bulk when she struck a mine or was struck by a torpedo aft, in way of the machinery compartment. This compartment extended over 20 per cent. of the length of vessel, whereas the floodable length at that part was 15 per cent. It is clear, therefore, that the vessel would sink, and this she did, grounding in 14 fathoms after being towed about 2 miles.

16. Three days after leaving the builder's yard this ship, 400 ft. long, was torpedoed when proceeding round the coast in "light" condition. No. 2 hold, immediately forward of the combined engine and boiler room was subdivided by a wood bulkhead to provide a temporary coal bunker, communicating with the boiler room through two W.T. doors. These doors were open at the time of the casualty, as was also that at the after end of engine room affording access to the shaft tunnel. The torpedo struck on the port side towards the forward end of No. 2 hold (97 ft. long), making a hole 30 ft. by 18 ft. The W.T. doors at the after end could not be closed on account of the coal, so water entered the machinery compartment and shaft tunnel, the door to the latter not being closed until three-quarters of an hour after the vessel was torpedoed. The suction pipes through No. 2 to No. 1 hold were damaged by the explosion, and water thus obtained access to No. 1. Water was also found in No. 3 and 4 holds, due, the surveyor thought, either to the bulkheads having originally been not fully watertight, or to their having been shaken by the explosion. The vessel remained afloat for some time, being ultimately beached some 14 or 15 hours after the casualty. That she survived at all under these circumstances was due to her light condition.

17. In the case of this vessel, 338 ft. long, and built abroad, the torpedo struck in way of No. 2 hold, making a hole 23 ft. by 17 ft. The vessel heeled to 25 deg., but remained afloat until beached 18 hours afterwards. No. 2 hold was divided by a wood bulkhead, and communication was possible between the after end and the combined engine and boiler room through a watertight door. This door was closed before the casualty, whilst the only other W.T. door fitted, viz., that to tunnel, was satisfactorily closed after the torpedo struck. Hay filled No. 2 hold and 'tween decks, except that some shingle ballast was in the 'tween decks at the after end. The torpedo struck about 23 ft. from the after bulkhead of No. 2, so this hold was immediately flooded. The after bulkhead was subsequently found to have a permanent set of 6 in. about 9½ ft. above the tank top; and through strained rivets and boundary bars, as also through the frame fastenings of watertight door, water found its way into the engine and boiler room and was at the same level as in No. 2 by the time the vessel was beached. The starboard suction to No. 1 hold was broken where it passed through No. 2, but the fractured end was nearly choked by the hay cargo, so that only 4 ft. of water was found in No. 3. Water also passed to a depth of 11¼ ft.—through the bulkhead at the after end of the engine room—into No. 3 hold, and thence into No. 4 hold to a depth of 5 ft. by way of the bulkhead at the after end of No. 3, and through defective fastenings in tunnel plating in Nos. 3 and 4 holds, so that water also accumulated in the tunnel. The surveyor pointed out the undesirability of the usual method of fastening racks, shelves, brackets, &c., on tunnel plating with plain neck bolts without grummets or washers. In this vessel there were many loose bolts through shaft tunnel plating, supporting spare gear; and in other vessels bolt holes have been found in W.T. bulkheads where fittings have been removed. The bulkhead at the after end of No. 2 hold was fully tested by the casualty, and, being next the machinery space, had no support from cargo on the side opposite the water pressure. The permanent set mentioned above seems to suggest structural weakness under this pressure, but on the other hand the scantlings were fully equal to present British practice, whilst other bulkheads of similar size have successfully withstood the pressure. Probably, as the surveyor suggests, the bulkhead was strained by the force of the explosion, whilst there is also a possibility that part of the deflection may have been caused by the swelling of the hay cargo. At the time the vessel was torpedoed her draught was about 5½ ft. less than when fully laden and this circumstance largely account for her remaining afloat.

18. This vessel, 285 ft. long, when fully laden with a general cargo, was torpedoed forward and turned right over and sank in 25 minutes. This result was inevitable, seeing that the torpedo opened up a hold 122 ft. in length, and that the estimated metacentric height at the time was 1¼ ft.

19. This passenger steamer, 254 ft. in length, struck a mine abreast No. 1 hold, but continued to float, apparently without listing. This hold occupied 16 per cent. of the vessel's length and contained a general cargo of casks of beer, oil, vinegar, hops, &c. The floodable length, assuming 60 per cent. permeability, was 18 per cent. of the length of vessel, so the vessel should have

remained afloat, as she did. The draughts of the ship after damage show that the water in No. 1 hold very nearly reached the level of the top of the after bulkhead of this compartment, so 60 per cent. permeability evidently represents this case of general cargo very well. The bulkheads were thus fully tested and stood perfectly, with slight leakage only, although the length (35 ft.) of hole made by the explosion was only 6 ft. less than the length of No. 1 hold.

It should be mentioned that at an early stage of the submarine campaign the Board of Trade issued special instructions as regards certain features of construction, and as to precautions to be taken when a vessel was in a submarine area or danger zone, which embodied experience gained with earlier vessels, mined or torpedoed; a copy of a circular issued to shipowners and masters on this subject has, by permission, been given in the appendix. It will be remembered, too, in this connection, that this Institution made important recommendations, having for their object the increased safety of ships in view of the submarine menace. These recommendations were forwarded to the Admiralty, the Board of Trade, and the Shipping Controller, and were published in the Trans. I.N.A. for 1918 (vol. ix., page 37).

A consideration of the cases cited above, and of the many others analysed, prompts the following conclusions and observations:—

1. Many ships after damage remained afloat and reached port, so it is clear that in these cases the watertight subdivision was sufficient under the actual conditions as to lading.

2. Remembering the considerable longitudinal extent of the damage from mine or torpedo, the damage from such causes to a small ship is more likely to be fatal, on the average, than that resulting from collision; whereas for large ships, capable of floating with two adjacent compartments opened to the sea, the maximum direct damage from mine or torpedo represents the maximum effect likely to be caused by a collision blow in the region of a bulkhead, and such vessels should survive. Some of the large vessels which were sunk were not so well subdivided as recommended by the recent Bulkhead Committee; had they been so divided, and had doors and sidelights been closed, such vessels would have continued afloat.

3. It is clear, from the cases cited, that many large vessels did not survive damage from a single mine or torpedo, and the reasons for this, acting singly or in combination, were:—

(*a*) Watertight doors were open which were not, or could not be, closed after the casualty, thus giving water access to compartments not directly affected by the explosion. Among the causes likely to prevent, or render inoperative, the closing of doors after the casualty may be mentioned: Distortion of bulkheads caused by explosion; sudden inrush of water through the doorway, coupled with delay in closing from above; presence of coal or debris washed into the doorway; and, probably, distortion of bulkhead due to water pressure on one side. In determining what bearing these facts may have on ordinary marine casualties, it is necessary to consider whether such casualties are likely to occur so suddenly or unexpectedly as under war conditions. It might be presumed that during a fog, or when a collision seems imminent, all watertight doors would be closed and other precautions taken to minimise risk. On the other hand, it is proverbially the unexpected that happens, and many cases might be cited where ships have received ordinary marine damage with watertight doors open. In such cases doors constitute a distinct source of danger, the causes tending to make them inoperative being similar to those mentioned above. The Bulkhead Committee recognised the possible danger of open doors, and recommended that the number of openings in bulkheads should be reduced to the minimum compatible with the design and proper working of the ship; they also suggested regulations for assuring that the doors should be kept in thorough working order. The possibility of dispensing entirely with watertight doors on main transverse bulkheads was thoroughly discussed by the committee, and the possible dangers involved in doing so were considered; but in the light of subsequent experience the matter appears to deserve reconsideration, particularly as open doors may lead to the vessel listing considerably, thus making it difficult to get boats away. It would seem possible to dispense with such doors in the machinery compartments of large transatlantic liners designed to operate continually between particular ports, and in large passenger and excursion steamers engaged on relatively short runs. If in certain cases it seems particularly inconvenient from considerations of easy communication to dispense with doors altogether, it would still be desirable from the point of view of safety to fit the doors high up rather than low down in the holds. In particular, it would seem that the doors leading to shaft tunnels, where there is a minimum of traffic, could generally be done away with, access to the tunnel being gained through a watertight trunk abaft the after engine-room bulkhead, as recommended by the committee of this Institution and as actually carried out in many vessels. It may be added, in passing, that the difficult problem of bunker doors would be solved in cases where oil fuel could be adopted.

(*b*) Below the bulkhead deck sidelights were left open, and these became immersed under the influence of sinkage and heel, combined in some cases with the effect of trim, thus admitting water to intact compartments. In a large vessel there may be several hundred sidelights below the bulkhead deck, a considerable proportion of which are capable of being opened. Recent experience goes to show that with the usual organisation on board ship it is most difficult to ensure that all sidelights are effectively closed, even when stringent orders have been issued to this effect.

(*c*) Suction pipes were often fractured in damaged compartments, thus putting other spaces in communication with the sea. Early experience in this respect led to a recommendation by the Board of Trade that an efficient non-return valve should be fitted at the ends of such pipes, whilst this Institution advised, on the same subject, that a screwdown non-return or similar valve should be fitted, to be worked from the bulkhead deck. This recommendation has been generally acted upon.

(*d*) Bulkheads and tunnels were found to be leaky through defective caulking, through bolt and other holes left in the plating, and through faulty fastenings. The complete carrying out of the Bulkhead Committee's recommendations as to inspection and hose-testing of bulkheads and tunnels, and careful inspection during periodical surveys, should ensure the discovery, and lead to the remedy, of defects such as those under consideration.

(*e*) Pipes such as voice pipes and pump suctions from hotwell were carried through bulkheads low down in holds, without valves at the bulkheads.

(*f*) Air-escape pipes and test pipes were sometimes carried a short distance only above the tank top, some with and others without stopcocks or screw-caps at their upper ends. At the time of casualty stopcocks have been found open and the screw caps provided have been found not in position, so that water obtained access to empty spaces. The recommendation of the Bulkhead Committee that air pipes should extend at least as high as the bulkhead deck thus appears to be a reasonable one, whilst it seems desirable that sound pipes should be treated similarly.

4. Referring next to the subject of the structural strength of bulkheads, it was found, in the great majority of ships which came into port after being damaged, that the bulkheads bounding damaged compartments had stood the water pressure quite satisfactorily, and some of these were fully tested. In the cases of two or three vessels which foundered it was stated that bulkheads gave way; but in one of these the explosion occurred close to the bulkhead, which was probably strained thereby, and this would be aggravated by the severe stresses set up by the heavy weather experienced; whilst in another the leakage past a bulkhead occurred when the ship was in light condition, so that no question of structural strength appears to arise here. Reviewing all the evidence, therefore, it is submitted that nothing has occurred which throws doubt upon the adequacy of the scantlings for bulkheads recommended by the Bulkhead Committee. It will be remembered that that committee made tests on actual bulkheads and, as a result, adopted scantlings somewhat in excess of previous practice, with more efficient end connections; and war experience warrants the conclusion that the scantlings so determined are sufficient for their purpose, with a reasonable margin of safety.

5. War experience has drawn renewed attention to the question of stability in vessels subdivided transversely. Previous experience and investigation had led to the conclusion that vessels damaged within their power of flotation would in general remain upright or without serious list, and this has been fully justified by many recent examples. Moreover, some vessels which capsized, and others which took a dangerous list, did so in consequence of compartments being flooded other than those necessarily opened to the sea. It is clear, therefore, that if the integrity of all bulkheads except those actually damaged by collision or explosion could be assured, the possibility of dangerous heeling developing would be reduced to a minimum. The liability of a vessel to list after stated damage depends upon the metacentric height at the time. If this is reduced to a small value to obtain maximum steadiness at sea, it is very probable that heeling will develop in the early stages of flooding, although it may diminish or disappear as the water within the vessel rises. In such cases no ill effects will be experienced unless it immerses open side ports, or the bulkhead deck if the injury extends above that deck; but if the damage is so great as to cause ultimate foundering, any serious permanent list would interfere with the getting away of the boats. The metacentric height actually given to a vessel is determined by several considerations. For steadiness at sea, this height should be small; to avoid undue heeling under the influence of wind pressure—particularly in high-sided vessels—it should be moderate in amount; whilst a third consideration is that just mentioned, viz., that after considerable damage dangerous heeling should not result. If it could be assumed that all ports below the bulkhead deck would be closed at the time of the casualty, a reasonable standard for determining the requisite metacentric height in large passenger vessels would appear to be that it should be at least sufficient to prevent such serious permanent list as would prevent the getting away of the boats when a length of ship equal to the floodable length amidships was opened to the sea.

Reviewing, therefore, the experience gained under war conditions, it will be seen that, whilst it has shown that arrangements designed to minimise risk have not, for various reasons, been fully effective, and that there may be possibilities of improvement in some details, the results, given the conditions actually existing, were such as might have been anticipated from previous knowledge. One word I should like to add in conclusion. No one who has had occasion to look into the details accompanying the torpedoing or mining of mercantile vessels can refrain from expressing the greatest admiration for the determination, coolness and courage with which the officers and men—including the engineering *personnel* in their specially trying situation below—met the risks inseparable from the ruthless methods of the enemy. By their conduct in "carrying on" unflinchingly in face of these risks, they certainly deserved the thanks so freely tendered them by a grateful country.

APPENDIX I.

COPY OF QUESTIONNAIRE SENT OUT BY THE BOARD OF TRADE TO ELICIT INFORMATION RELATING TO THE CIRCUMSTANCES ATTENDING THE MINING OR TORPEDOING OF MERCANTILE VESSELS.

1. Type of ship and dimensions.
2. Approximate draught before the casualty occurred.
3. Was the damage caused by a mine, a torpedo, by collision, or otherwise?
4. Where did the mine or torpedo or colliding vesse strike the ship?
5. Length and position of compartment or compartments affected by the explosion, gunfire or collision.
6. Nature of the contents of these compartments.
7. Description or sketch of bulkheading arrangements in the part of the ship flooded, showing longitudinal bulkheads, if any are fitted, as well as transverse bulkheads.
8. What watertight doors were fitted in the lower part of the bulkheads within the flooded part?
9. Were any of the doors capable of being closed from the bridge?
10. What other arrangements were fitted for closing the doors?
11. Were any of the lower doors in the flooded part of the vessel open at the time the vessel was struck?
12. Were these doors closed after the vessel was struck?
13. By what means were the doors closed, and in about what time?
14. What watertight doors were fitted in the upper part of the bulkheads, and were these doors closed before or after the vessel was struck?
15. Did water flow from the compartment in which the vessel was struck to any other compartment through a doorway in a watertight bulkhead?
16. Did water flow from the compartment in which the vessel was struck to any other compartment through a broken bilge pipe, or in any other manner?
17. If the vessel remained afloat, what was the approximate draught, forward and aft, when she arrived in port, or just before she was beached?
18. Did the vessel take a heel, and if so to what angle, approximately?
19. How long did the vessel remain afloat, and did she sink on an even keel, or by the bow, or by the stern?
20. Were there any side scuttles or other openings in the ship's side below the uppermost continuous deck?
21. What was the effect of the explosion on the glass and metal portions of the side scuttles?
22. Were any of the side scuttles open at the time the vessel was struck?
23. Were the side scuttles closed immediately after the casualty?
24. Did water enter the ship through side scuttles in any compartment other than that in which the explosion occurred?
25. Did water enter the ship through any soil-pipe, ash-shoot, or similar connection in any compartment other than that in which the explosion or collision occurred?

APPENDIX II.

NOTICE TO SHIPOWNERS AND MASTERS ISSUED BY THE BOARD OF TRADE.

SPECIAL PRECAUTIONS WHEN A VESSEL IS IN A SUBMARINE AREA OR DANGER ZONE.

1. This notice is a new edition, with important alterations and additions, of two Notices previously issued by the Board of Trade with regard to the special precautions to be taken when British vessels go through a danger zone. The preceding notices were issued in August, 1915 (Notice 365), and May, 1916 (Notice 374); and these notices are now cancelled. This notice, which is issued after consultation with the Ministry of Shipping, applies to all sea-going British merchant ships, whether chartered or requisitioned by His Majesty's Government or not. Areas in which there is a possibility of attack by enemy submarines or collision with mines are indicated in the Admiralty Instructions to Masters.

2. When a ship strikes a mine or is torpedoed it is impossible to rely on there being sufficient time to take measures to keep the vessel afloat. Experience has shown that open watertight doors, and open side scuttles or other apertures in the ship's side have caused the loss of vessels which might have remained afloat. Further, as the damage by a torpedo or mine may be so great that no measures could keep the vessel afloat for long, arrangements made in advance for getting all persons on board into boats or upon rafts are of great importance. It is essential therefore that where a vessel is going through dangerous waters, all possible arrangements, in view of an attack by submarine or collision with a mine, should be made in advance; and those concerned should take, or ensure the taking of, the precautions in this notice, which has been drawn up after careful consideration of the facts relating to the loss of a large number of vessels through mine or torpedo. Owners and masters are primarily responsible for taking these precautions, or for ensuring that they are taken.

3. In addition to the precautions indicated in this notice, those concerned should take any special and additional measures that may be necessary in particular circumstances. Attention is called to the serious consequences in which those responsible would be involved should the loss of a ship, or loss of life, result from the omission to take any necessary precautions.

4. This notice comes into operation immediately upon issue, but if full compliance with any requirement would seriously delay the sailing of a vessel, such compliance may be deferred. In such cases temporary arrangements should, wherever possible, be made to secure as far as

practicable the objects in view; and the whole of the requirements should be carried out as soon as practicable after the issue of the notice.

5. *Watertight Bulkheads and Tunnels.*—Care should be taken to maintain all bulkheads and tunnels, which are intended to be watertight, in a thoroughly watertight condition.

6. *Watertight Doors.*—Doors in watertight bulkheads, which are not essential for the working of the ship at sea on the intended voyage, should be closed and secured in that position before the voyage commences and kept closed while at sea. All watertight doors in passage-ways from firemen's quarters to the stokehold should be kept closed, the firemen using the fidley ladders. Where suitable provision is made for the exit of the crew or passengers from their quarters by means of ladder-ways through the deck above, the watertight doors which are required solely for access to those quarters should be kept closed. In all cases where this is practicable, a watertight trunk should be fitted from the bulkhead deck to the shaft tunnel, and the tunnel door kept closed. All possible arrangements should also be made to enable watertight bunker doors to be kept closed in a danger area, *e.g.*, if there are side bunkers or bunkers the doors to which are in non-watertight bulkheads, coal should be worked from these in danger areas and the doors in watertight bulkheads kept closed. In other cases shoots should, if practicable, be fitted so that coal carried between decks or in the bridge space may be used and the opening of watertight doors be avoided. Failing these possibilities, as much coal as practicable, having regard to safe working and weather conditions, should be stowed on the stokehold plates for use in the danger zone. If it is impossible to work the ship at sea without opening some particular door, the door is only to be opened when absolutely necessary, and with the express permission of the master. During the time that doors are open the members of the crew detailed for this work should be ready to close them as soon as the order is given. The door should be closed again as soon as possible, and the fact reported to the master at once.

7. All watertight doors which are liable to be opened at sea should be kept in thorough working order, and should be capable of being closed expeditiously. Doors worked by a ratchet cannot be closed quickly enough, and whenever possible the ratchet should be supplemented by a wheel and handle or by some other gear giving continuous closing action.

8. The master should appoint the chief engineer or some other officer, as the officer definitely responsible for the working of the watertight doors in each part of the ship. Before the ship proceeds to sea on any occasion such officer should have the doors opened and closed in his presence, and should satisfy himself that they are in good working order, and can be quickly closed. An entry should be made in the official log, and signed by the master and by the responsible officer every time this is done. Before the ship leaves the United Kingdom at the beginning of a voyage the officer responsible for the doors in each part of the ship should give the owner or his marine superintendent a certificate in writing to the effect that the doors were worked in his presence and closed to his satisfaction, and should report to the master that he has done so. Opportunities should be taken as often as possible during the voyage to see that the doors remain in good condition, and door drill should be practised at regular intervals, an entry being made in the official log on each occasion.

9. Great care should be taken to ensure that any portable plates on the bulkheads or tunnels, any manholes in double bottoms, or any sluice valves are thoroughly watertight before the ship proceeds to sea.

10. *Bilge Pumps.*—All bilge pumping installations should be maintained in efficient condition. The bilges and strum boxes in each hold and machinery compartment should be cleaned, and any defects in the system remedied before proceeding to sea. If practicable an additional screw-down non-return valve should be fitted in each pipe line on the watertight bulkhead inside the compartment in which the strum box for that line is situated. The valves should be secured to the bulkhead in each case by studs screwed into the bulkhead.

11. *Openings in the Ship's Sides.*—All side scuttles and other openings in the ship's sides below the uppermost continuous deck, and in the first tier of deck erections above that deck should be kept closed so long as the ship is in a submarine area with the exception of apertures such as ash-shoots which require to be opened for the working of the ship. Ash-shoots and slop-shoots should be fitted with suitable appliances for closing them watertight unless the shoots extend to the bulkhead deck and at least 15 ft. above water, and the shoots should be kept closed except when actually in use. Sanitary discharges and scuppers not fitted with appliances which will be watertight under pressure should, if below the bulkhead deck and less than 15 ft. above water, be closed up and, if necessary, other arrangements made. Any other sanitary discharges, the use of which can be dispensed with, should also be closed up. Where side scuttles below the uppermost continuous deck are fitted with inside metal deadlights and/or outer metal plugs the plugs should be shipped in place and the dead lights closed; but if the side scuttles are not provided either with dead lights or outer plugs they should be permanently closed and made watertight by riveted or bolted plates or in some equally efficient manner unless they are at least 15 ft. above water.

12. *Berthing of Passengers.*—All passengers should be berthed when in a danger zone above the uppermost continuous deck if there is sufficient accommodation, and the watertight doors and scuttles in the passengers' quarters below that deck should be kept permanently closed.

13. *Lighting.*—All living and working spaces liable to be rendered dark through the closing of side scuttles should be provided with adequate artificial light. In addition adequate provision should be made for giving light for egress from the living compartments to the deck and for the launching of the boats and the embarkation into them of those on board. For this purpose lanterns placed in suitable positions are recommended, as electric lighting systems may be rendered inoperative by a mine or torpedo explosion. Lanterns should be kept burning in a submarine area, but obscured from view until required. A supply of electric torches should also be provided.

14. *Warning Engine-Room Staff.*—Suitable provision should be made to enable the master or officer in charge to give immediate warning in case of emergency, to those men who may be on duty in the engine-room, stokehold or other compartment below deck. A mutual understanding should exist whereby these men may know that they will receive notice by a signal agreed upon when it is time to leave their posts.

The explosion of a mine or torpedo may result in the engine-room telegraph or telephone being disabled, and arrangements should therefore be made for conveying a message promptly in some other way.

15. *Prevention of Heeling.*—It is very important that a vessel should have sufficient initial stability to prevent her taking a serious list if holed by a torpedo or a mine. It is desirable, of course, that the freeboard of the vessel should not be unnecessarily reduced by the addition of water ballast, but if the nature or amount of the cargo, taken in conjunction with the amount of bunker coal on board is such at any time that a sufficient margin of initial stability cannot otherwise be obtained, some or all of the ballast tanks should be filled. The vessel should not, however, be overladen.

If the initial stability is not so ample as to prevent any danger of a serious list, and if the vessel is constructed with longitudinal bulkheads, such as wing bunker bulkheads, precautions should be taken to allow water which may enter the vessel to flow as freely as possible through the longitudinal bulkheads; for example, the doors of wing bunkers should in such a case be left open.

16. *Emission of Smoke.*—It should be realised that the presence of smoke which can be seen for many miles is often the only indication given to a submarine of the presence of a vessel.

Particular care should therefore be taken with the stoking of the boilers when in a danger zone, so as to minimise the amount of smoke emitted. In this connection it is advisable to stoke lightly and stoke often, keeping the fires clean and even.

17. *Precautions against Shell Fire.*—Wooden plugs should be prepared and kept handy to plug up shell holes. Suitable plugs can be made of spruce, about 2 ft. in length and about 8 in. in diameter, tapering to 2 in.

18. *Lifeboats.*—The lifeboats attached to davits should, if possible, whilst the vessel is in the danger zone, be carried in the outboard position griped to spars or secured in some other efficient manner so as to be ready for immediate lowering. Inboard boats should be transferred to the ship's side under davits ready for hooking on. In order to provide protection for any passengers or seamen who may, in an emergency, be compelled to leave the ship without sufficient clothing, every boat should be furnished with a number of blankets rolled up tightly and properly stowed under the thwarts or elsewhere. Boat drill should be practised and life-saving appliances examined as frequently as possible. Masters and officers should carefully inspect the boats and satisfy themselves that every lifeboat has on board all the equipment required by the Life Saving Appliances Rules, including a sufficient quantity of provisions and water in good condition; that plugs are always securely attached to the margin of the plug holes; and that the boats' falls are so stowed as to be immediately available for use without liability to become fouled. For this purpose the falls should be wound on reels or stowed in some equally efficient manner. Masters and officers should also impress on their crews that the safe lowering of a boat depends largely upon seeing that the falls are quite clear for running, and that while the boat is being lowered the men tending the falls lower in unison so as to keep the boat fairly level. In order to prevent a boat coming down with a run, where lowering bollards are not provided, a round turn should be taken with the fall round the davit below the cleat before the falls are coiled. Each lifeboat should be provided with two painters; one should be fitted with a strop and toggle and the end should be led forward and kept belayed to a cleat or other suitable fitting fixed on the deck or bulkwark, the boat's painter being coiled in the boat for use if required after launching. In the case of lifeboats stowed on the poop, or near the after end of the ship, the cleats should be so placed that boats when lowered and freed from the tackles, with the ship light, will be held by the ropes clear of the counter and propellers. The covers of all lifeboats and pontoon lifeboats should be taken off before entering the submarine area, and all obstructions, such as would prevent the lifeboats floating off the vessel's deck, should be removed, including the boats' gripes when weather permits. In order that they may have the best chance of floating clear, a number of the pontoon lifeboats (where such are carried) may, if necessary, be stowed elsewhere than abreast of davits.

19. *Life-Rafts and Buoyant Apparatus.*—Every passenger steamer which is, or may be, employed in a submarine area or danger zone should be provided with life-rafts, buoyant deck seats, or other buoyant apparatus suitably stowed on deck, in addition to the lifeboats and other appliances required by the Life Saving Appliances Rules. If possible the buoyant apparatus should be sufficient to accommodate 50 per cent. of the total number of persons on board.

20. Rafts and buoyant apparatus should be stowed in such a manner that they will be free to float off the vessel's decks on their gripes being slipped. They should not be lashed or have any fastenings other than gripes. Wire rope gripes fitted with a short length of chain and a slip link are considered the handiest form of quick release.

21. *Life-Jackets.*—Life-jackets should be so placed as to be readily accessible, or issued to the persons for whom they are available.

In a passenger ship the master must satisfy himself that every passenger has a life-jacket issued to him, has been shown how to put it on, and the correct position in which it should be worn and has been instructed either to wear it or to keep it within immediate reach ready to put on while the ship is in a danger zone.

Musters should be held at short notice as soon as practicable after leaving each port in the danger zone and at frequent intervals thereafter, at which all passengers should be required to attend with their life-jackets, putting them on under proper guidance. Not more than two types of life-jacket should be carried on board any one ship.

22. *Warm Clothing, &c.*—Passengers and seamen should be enjoined to keep themselves warmly clothed at all times, and to be ready for any emergency. The seamen's discharge books should be distributed to them on entry into the danger zone.

C. HIPWOOD,
Assistant Secretary.

Marine Department, Board of Trade,
June, 1917.

ITABIRA IRON ORE, BRAZIL.—The Itabira Iron Ore Company, says the British Chamber of Commerce, Rio de Janeiro, has just obtained additional powers for the establishment of a smelting plant, construction of a branch line and a port on the River Piraqué Assu. It may run its own vessels for export, *viâ* Victoria, but not for other traffic unless with special authorisation. National coal and other materials will be used when shown to be practicable—meantime, materials, machinery &c., will be admitted duty free. The works will be installed for an output of 150,000 tons per annum. News that "The Anglo-Brazilian Company" are in treaty for the transport of 1,000,000 tons of Itabira iron ore by the Santa Barbara Railway and destined for England, has created great interest. Rolling-stock for the transport is to be supplied.

EXPORT OF ELECTRIC ENERGY FROM SWITZERLAND.—Several of the Swiss hydro-electric plants, especially those relying upon low-pressure water power, have had to be projected on a scale more than sufficient for the summer demand of electricity, in order to be able to meet the greater requirements during the winter when water is scarce. Some of these works export their surplus power across the frontier and are then able to supply energy in the country itself on lower terms. During the last two winters the demand for electricity in the country has much increased owing to the dearth of coal, and the Swiss Government has been urged, in the interests of the national welfare, to prohibit the export of electricity. The Bundesrat therefore granted concessions for export only under certain restrictions, but has after due inquiry come to the conclusion that the suppression of the hydro-electric energy would not be in the interest of the country. The decision seems mainly to have been taken on the expert advice of the Swiss Hydraulic Commission. The annual meeting of Swiss electric installation firms, held in May at Luzern, on the other hand, unanimously depreciated the export of electricity. Any surplus electricity would much better be converted into heat to save coal; for that purpose more cables, switches and necessary apparatus, pipes and boilers, &c., would be wanted, and the general development of the electric industry was of greater importance to the country than the development of large power companies.

BUSINESS WITH ARGENTINA.—We read in the monthly review for June of the London and River Plate Bank, Limited, that United States shipments to Argentina continue to be both heavy and general; hardware, fencing wire, machine tools, and motor cars forming the bulk of the merchandise received during the month. For motor cars and lorries it must be admitted that American exporters have so thoroughly suited the needs of the great majority of users of cars as to command the River Plate market. There are still very few European makes, and still fewer British names, to be seen, even among the pleasure vehicles of Buenos Aires. In the country districts only American cars are obtainable, and are in universal use, together with cheap 8-h.p. tractors, utilisable also for power production by means of supplementary shafting. Attention may be directed to the good market for dredging material that the Argentine Republic offers at the present time. There are many projects afoot which will call for plant of varying character and capacity, though principally of the suction and bucket type; in addition to which it must be remembered that many of the dredging outfits now in use have suffered considerable depreciation in the last five years. Before the war, Dutch houses had what amounted to a practical monopoly of this valuable line; to-day it is questionable whether, in view of exchange and labour conditions in Holland, the same advantage exists. Their chief firms are, however, well represented, usually by practical engineers, and keep in close touch with Government Departments able to influence business in their direction. In railway material there is a gratifying increase in the arrival of goods from Great Britain, but Argentine Government orders still go to the States, the latest purchases being 25 locomotives at 42,500 dols. (U.S.) each, from the Baldwin Works, and a quantity of 37 kilos. per metre rails for 120 km. of track on the Central Northern system.

THE ROYAL AGRICULTURAL SHOW AT DARLINGTON.

(*Continued from page* 12.)

THE stationary steam engine has never been a typical part of the equipment of even the largest farms, and even the little hold it ever may have had has almost vanished owing to the development of the internal-combustion engine. Nevertheless, as many of the larger agricultural machinery makers are manufacturers of stationary engines as well there were, as might be expected, a few of such engines on view. On the large stand of the Agricultural and General Engineers, Limited, the association of firms now becoming known as the A.G.E., there was a horizontal 9-in. by 12-in. engine by Davey Paxman and Co., Limited, of Colchester, and a cylinder of a larger engine, 16 in. diameter by 27½ in. stroke, by the same firm. This was fitted with the Paxman-Lenz drop-valve gear. Messrs. Robey and Co., Limited, of Lincoln, showed a cylinder fitted complete with drop-valve reversing gear, and an excellent working model of a Uniflow engine which we understand is ultimately destined for the South Kensington Museum. The same firm had a single-cylinder, open-type vertical engine on their stand. These few exhibits practically comprised the whole of the stationary steam engines, but akin to these was the semi-portable locomobile type, represented by a compound engine of 100 brake horse-power manufactured by Messrs. Richard Garrett and Sons, Limited, of Leiston. The high economy of these engines, which are built up to 600 brake horse-power, is well known, and the extreme compactness of the plant, comprising as it does a boiler, superheater, engine and condensing plant built as a self-contained unit, is frequently a great advantage. The operation of even the largest sizes requires the services of only one man.

Whereas a few years ago the motive power for the exhibits of machinery in motion would have been almost exclusively obtained from portable steam engines, these have now been practically superseded by internal combustion engines. There were also, of course, numerous stands where the latter engines were exhibited for their own sake, or shown as part of electric generating units. The engines on view ran into hundreds, and ranged from tiny little ones of about 1 h.p. to heavier engines up to 75 brake horse-power shown in operation, and even larger ones not running. For stationary work the ordinary four-stroke single-cylinder horizontal open trunk type seemed to hold its own with ease, variants from this type being comparatively few. Messrs. Blackstone and Co., Limited, of Stamford, had a fine collection ranging from 5 brake horse-power to 50 brake horse-power. Messrs. Ruston and Hornsby, Limited, of Lincoln, and Messrs. Crossley Brothers, Limited, of Manchester, also had numerous engines, these two firms both exhibiting examples of their high compression solid-injection cold-starting crude oil engines with which fuel consumptions of less than 0·4 lb. per brake horse-power can be obtained at full load. Messrs. Petters, Limited, of Yeovil, favour the vertical enclosed type, of which they showed numerous examples, and the same remarks apply to Messrs. R. A. Lister and Co., Limited, of Dursley.

A new series of oil engines designed to use ordinary paraffin as fuel and to start up immediately from cold without either the usual preliminary run on petrol or previous heating by means of a blow lamp, has been designed by Messrs. Blackstone and Co., Limited, of Stamford. These engines are of the open horizontal four-stroke type, as illustrated in Fig. 6, annexed, and their ability to start from cold is not due to the use of high compression, as in the Diesel and semi-Diesel types, for in the Blackstone engine the compression is only 80 lb. per square inch. The peculiar feature of the engine, and the one to which it owes its characteristic, consists in the mechanical atomising of the injected oil by means of a jet of compressed air at 80 lb. to 100 lb. per square inch. At the side of the cylinder and driven by an eccentric from the crankshaft is a small single-acting air compressing cylinder with a piston of the plunger type. During every suction stroke of the engine this forces a puff of compressed air from a jet in the cylinder head directed axially

THE BLACKSTONE COLD STARTING OIL ENGINE.

CONSTRUCTED BY MESSRS. BLACKSTONE AND CO., LIMITED, STAMFORD.

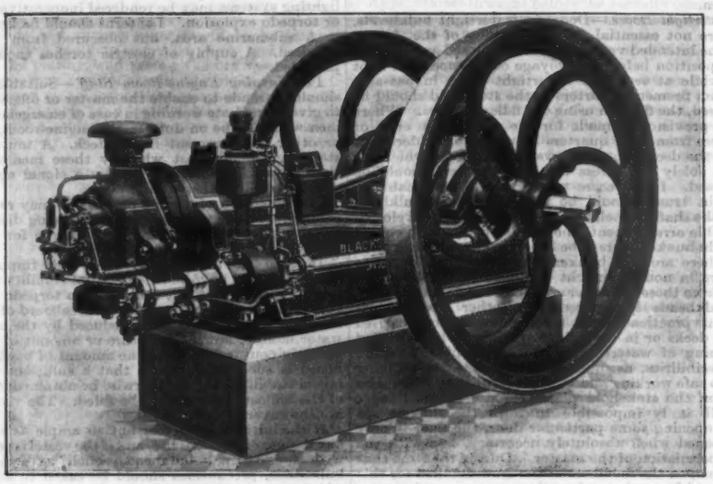
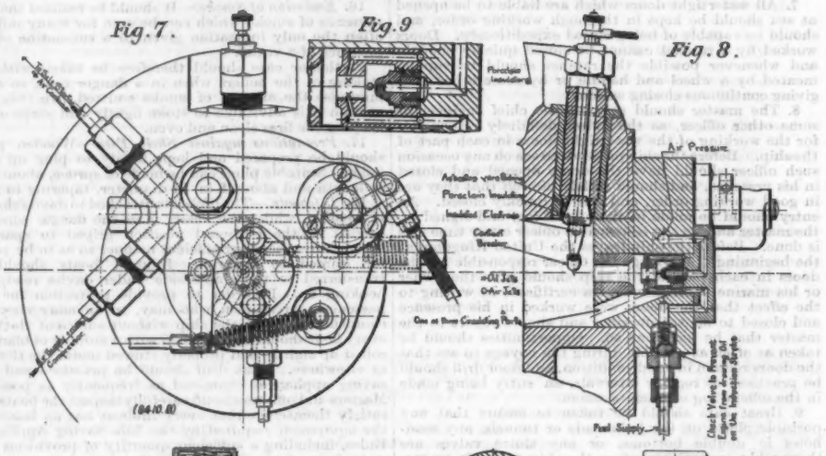
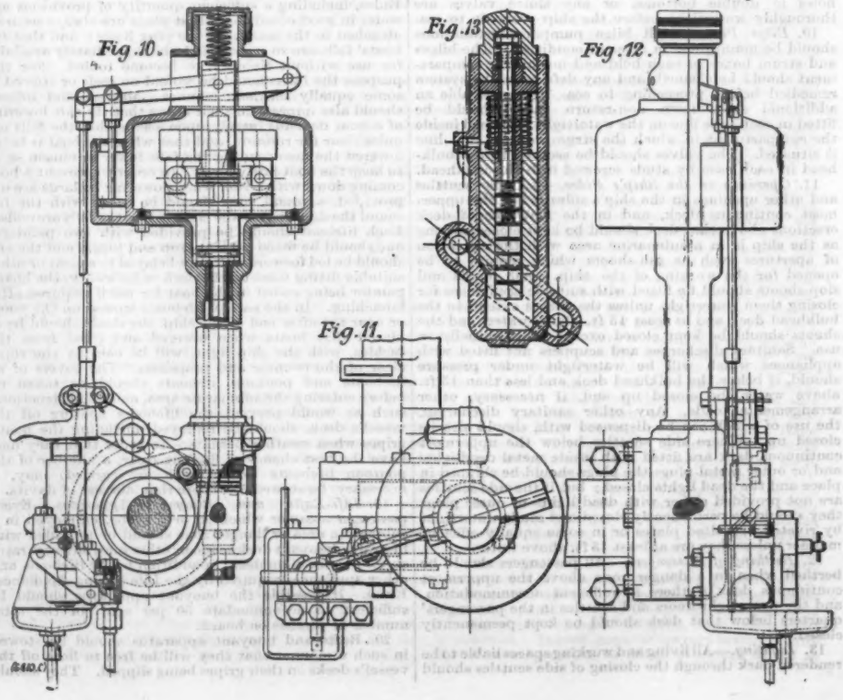


FIG. 6.





along the centre line of the cylinder. This jet sweeps through a circular port and picks up the oil which is at the same time being forced through opposite holes in the side of the port, by means of the fuel pumps. The jet of compressed air completes the atomising of the oil. The connections at the back end of the cylinder are shown in Fig. 7, while Fig. 9 gives a diagrammatic section through the cylinder head and makes clear the action of the air jet. It will be seen from this illustration that there are three circulating ports in the cylinder head through which part of the cylinder contents are induced to flow by means of an injector-like action of the air jet. These hot burnt gases then mingle with the mixture entering the cylinder and complete the vaporisation of the fuel. An enlarged view of the air and oil ports is given in Fig. 8. The fuel pump and governor are illustrated in Figs. 10 to 13. The action of the governor, as the speed of the engine increases, is to raise a wedge piece which reduces the stroke of a cam-driven lever and therefore of the fuel pump. The plunger of the latter is a ground fit in the barrel in which it works, and is returned by the action of a spring. Ignition is effected by a low-tension magneto with a contact breaker inside the cylinder. The magneto is of the tripping type, so that an equally powerful spark is obtained at all engine speeds. The smaller engines are easily started by hand, but a self-starter is fitted to the larger sizes. This is merely a hand-operated valve which lets a charge of compressed air into the cylinder from a small reservoir, which latter is recharged automatically by the engine itself. Whichever method of starting is adopted the engines seem able to get away instantly from the cold state, and their starting would, in fact, compare very favourably with that of a petrol engine. Engines of the type described are built in 13 sizes, ranging from three brake horse-power to 42 brake horse-power.

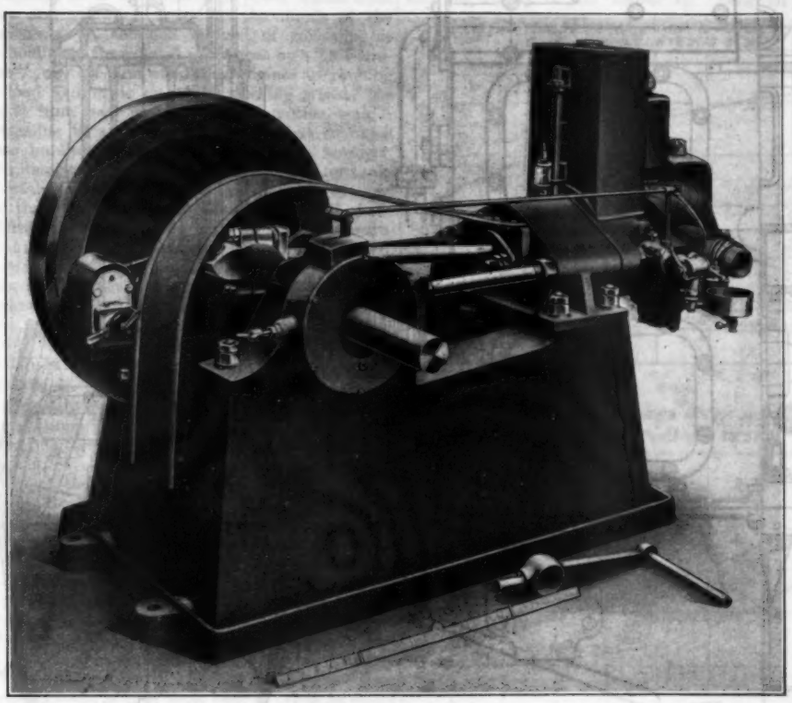
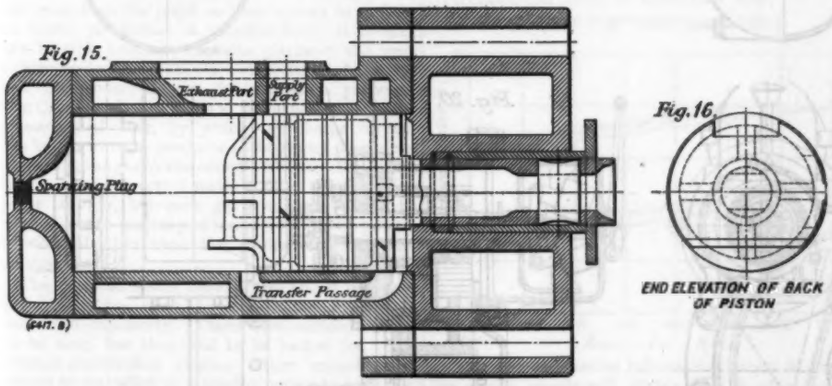


FIG. 14.



FIGS. 14 TO 16. TWO-STROKE VALVELESS OIL ENGINE; MESSRS. HARDY AND PADMORE, LIMITED, WORCESTER.

Two-stroke engines of the smaller sizes were hardly to be seen, and apparently the simplicity and cheapness of this design are outweighed, for agricultural use, by the disadvantages centring around a closed gastight crank-case. Mention, however, must be made of a two-stroke horizontal valveless engine in which crank-case compression is eliminated. This was manufactured and exhibited by Messrs. Hardy and Padmore, Limited, of Worcester. The engine on their stand was of 5 brake horse-power, and was one of the few attempts which we noted to break away from stereotyped design.

An illustration of the engine in question is given in Fig. 14, annexed. It works, as already stated, on the two-stroke cycle and develops its rated power at 550 r.p.m. There is, as will be seen, no closed crank-case in which the charge is compressed prior to entering the cylinder, but this compression is carried out in a small auxiliary cylinder situated in front of the working cylinder. The engine will operate on either petrol or paraffin, being in fact intended for the latter fuel, although, as usual, in such engines a little petrol is required for starting. An adjustable governor is fitted direct on the crankshaft, and the engine is entirely free from gears, camshafts, tappet levers, valves and valve springs, so that great mechanical simplicity is obtained. The weight of the engine illustrated is about 11 cwt., and the overall dimensions are 60 in. long, by 38 in. wide, and 36 in. high. The main bearings are fitted with ring lubrication.

The action of the engine will be understood from the section of the cylinder given in Fig. 15. The piston is shown at the end of its out-stroke. As it moves back it closes both the inlet and exhaust ports and compresses the charge in the cylinder. A vacuum is formed in the front end of the cylinder until the front end of the piston uncovers the external port, when the space is filled with carburetted air. After the explosion of the compressed charge has taken place the piston is driven outward again and compresses the fresh charge in front of it. As the end of the outward stroke is reached the burnt charge escapes through the exhaust port, which is then uncovered, and at the same time the fresh charge passes from the front of the piston into the cylinder through the inlet port, which is then uncovered. Thus a working stroke occurs at every revolution of the engine.

Although the two-stroke engine is so little in evidence, as regards the smaller sizes—indeed it is surprisingly rare considering its popularity for motor boats, motor cycles, &c.—it was exhibited by several firms in the larger sizes. Messrs. W. H. Allen, Son and Co., Limited, of Bedford, showed in fact nothing but a collection of such engines, ranging from single-cylinder engines of 25 brake horse-power to four-cylinder engines of 100 brake horse-power. These were of the vertical hot-bulb type designed for heavy, crude or residual oil, and practically identical with those which have become so popular for marine work. Messrs. Robey and Co., Limited, of Lincoln, exhibited a very similar engine, as did also Messrs. Vickers-Petters, Limited, of Ipswich.

The latter firm have an ingenious arrangement to enable the engine to run light without difficulty. It is well known that when engines of the hot-bulb type are run at no load for anything more than a short time, there is danger of the bulb cooling so much that its heat is inadequate to fire the charge of oil, when, of course, the engine stops. In the case of multi-cylinder hot-bulb engines, some of the cylinder heads may become so cold that when the engine is required to take up its load again, the cooler cylinders are unable to restart firing without having their bulbs re-heated by the blow-lamp. To avoid this trouble Messrs. Vickers-Petters, Limited, arrange that at light loads a small auxiliary charge of oil is injected into the cylinder at a period of the stroke when it will not exert any appreciable driving power. Its combustion, however, maintains the heat of the bulb so that the engine can instantly resume its full duty when called upon to do so. The auxiliary oil is, of course, shut off when the engine is running normally.

The two-stroke crude oil engines exhibited by Messrs. Clayton and Shuttleworth, Limited, differed from general practice with regard to such engines in that they were built horizontally. The firm in question showed several sizes, the largest being an engine developing 75 brake horse-power in a single cylinder at a speed of 200 r.p.m. The engine was shown running, and the silence of its operation was noticeable. As the type was illustrated and described so recently in our columns we need not further refer to it now.

Turning back to the smaller internal-combustion engines, the large number of these which were of American make is hardly creditable to our manu-

RICARDO ENGINE FOR AGRICULTURAL TRACTOR; DARLINGTON SHOW.

CONSTRUCTED BY MESSRS. PETER BROTHERHOOD AND CO., LIMITED, ENGINEERS, PETERBOROUGH.

Fig. 17.

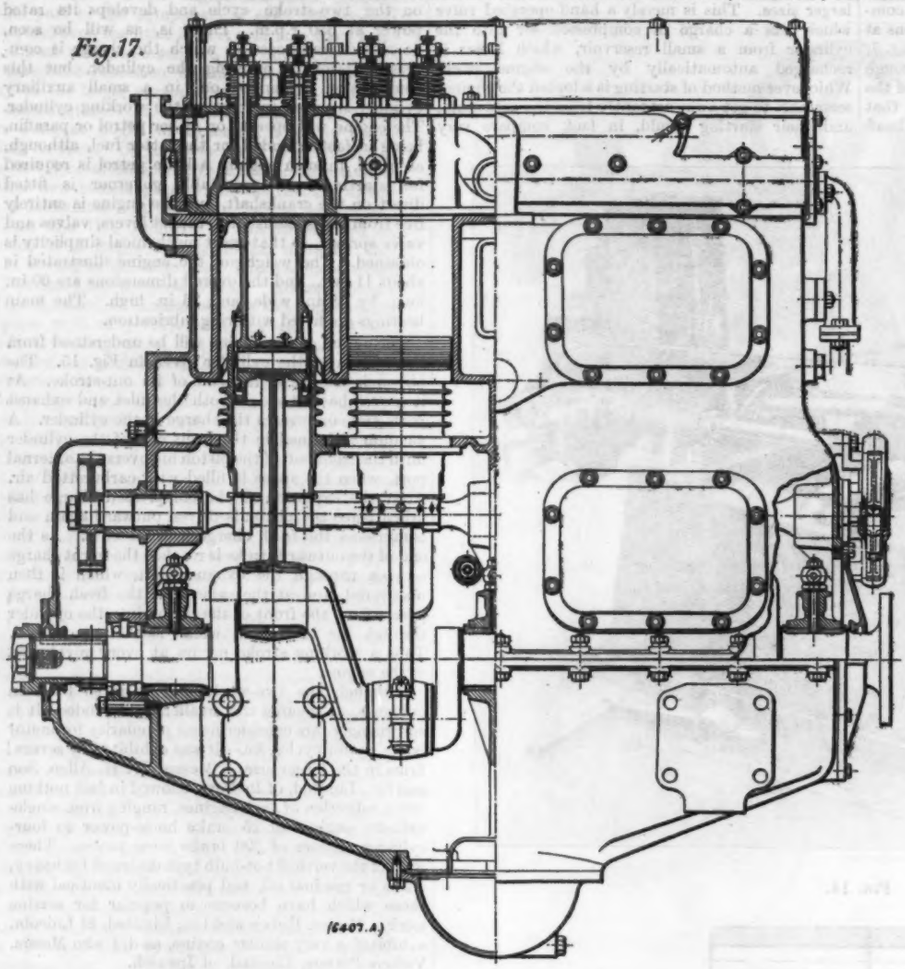


Fig. 18.

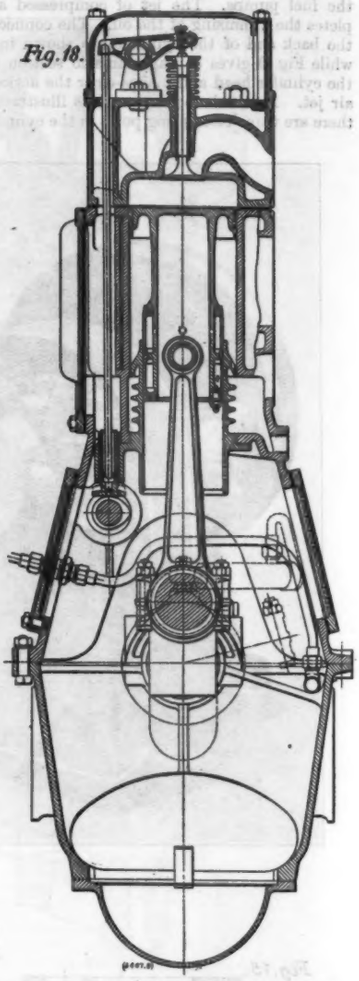


Fig. 19.

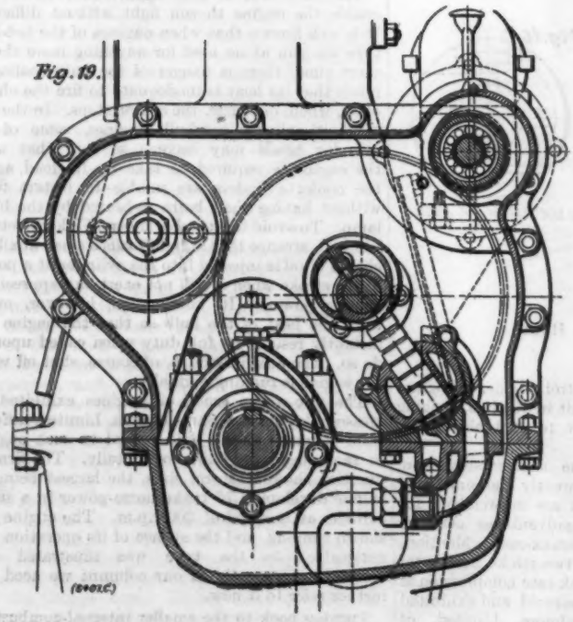
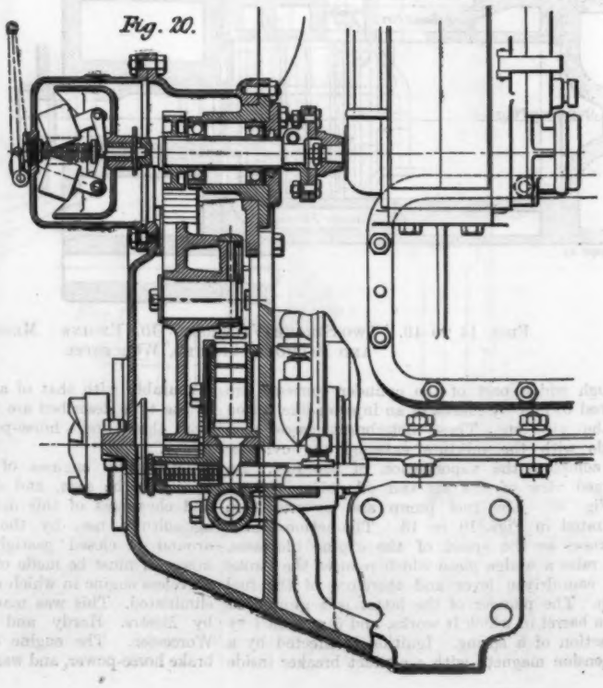


Fig. 20.



facturers. The commonest type was a horizontal open engine with a "hopper" water tank cast round the cylinder. The whole design was of the crudest, and in view of the roughness of both finish and workmanship, it is surprising that these engines find an extensive market, especially when one considers the excellence of the engine work which the British farmer expects and gets from our own manufacturers. However, their commercial success is undoubted, and it may be, as we heard suggested at the show, that their popularity is due, not so much to their cheapness, as to the illusion of power which their noise and vibration create in the minds of the purchasers. A common method of governing is the holding of the exhaust valve open by a "hit-and-miss" governor, and when these engines are running on load and firing on every working stroke, the racket from their gears, cams and motion-work is distressing to anyone who realises what so much noise implies. The hopper-type engine, however, with its absence of radiator or separate water tank, is certainly advantageous from many points of view, and the design is being developed by several of the British makers, generally with a marked improvement in details. Messrs. Crossley Brothers, Limited, of Manchester, exhibited such an engine which embodied, in fact, the same high-class design and workmanship as characterises their other engine work, and the result is a most attractive little prime mover which can be put on the market at a competitive price.

Gas engines hardly enjoyed as much representation as one might have expected, and it seems that these, like stationary steam engines, are less in favour for agricultural purposes than are engines using oil as fuel. We only observed three gas-producer plants at the show, these being on the stands of Messrs. Ruston and Hornsby, Limited, of Lincoln, the National Gas Engine Company, Limited, of Ashton-under-Lyne, and Messrs. Crossley Brothers, of Manchester. In all cases the engines were working in conjunction with producers built by the respective firms. The first two of the makers mentioned exhibited plants of the ordinary type, rated respectively at 22 brake horse-power and 44 brake horse-power, while Messrs. Crossley Brothers showed one of 37 brake horse-power, their producer being of the "open hearth" type, in which the fire can be seen and poked from the bottom, much as in the case of an ordinary household fire grate. This has obvious advantages, but we must say that the ashes from the plant on view appear to contain an undue proportion of unburnt fuel. It is only fair to add, however, that the producer was very lightly loaded, and possibly the poking of the fire had been overdone for demonstration purposes. The Crossley plant was fitted with the firm's patent rotating fuel door, by which the charge of fuel can be put into the producer without any possibility of spoiling the gas by the admission of air. Altogether it had many attractive features from the operating point of view, but such gas producers as will be wanted by the majority of farmers will be for powers considerably less than the plants on view were designed for.

The portable steam engine, appears, if one may judge from the show, to have suffered a severe decline in popularity. There were certainly a few to be seen, but they had to be looked for. The internal-combustion engine, either mounted on wheels or embodied in a tractor, seems to have displaced the portable steam engine from the position it once held as the standard prime mover of the agriculturist who did not possess the heavier and more costly steam traction engine. An oil-tractor can in fact be produced for less than 500*l.*, while a portable steam engine costs about 600*l.*, and, in addition to being materially cheaper, the tractor can take up its position under its own power and can also fulfil its primary functions of hauling ploughs or implements. An average oil tractor will give from 20 brake horse-power to 30 brake horse-power at the belt pulley and this is probably as much as the average portable engine will do, but so long as the makers of the latter persist in their use of the absurd and misleading "nominal" horse-power rating, it is impossible to make a fair comparison. In fact, we believe that the meaning, if it has one, of "nominal" horse-power differs with different manufacturers, and it is quite time that the Royal Agricultural Society refused to recognise the term or to permit its use in their catalogue.

As regards the design, either of portable or traction engines, there is little or nothing to be said, for these settled down along well established lines many years ago, and no material improvement seems likely. The steam traction engine, owing to its powers of locomotion and haulage, has a far greater security of tenure than the portable engine, and the ability of the former to "hang on the

Fig. 21. HORSE POWER, B.H.P. & FUEL CONSUMPTION CURVES (16. 6. 20)

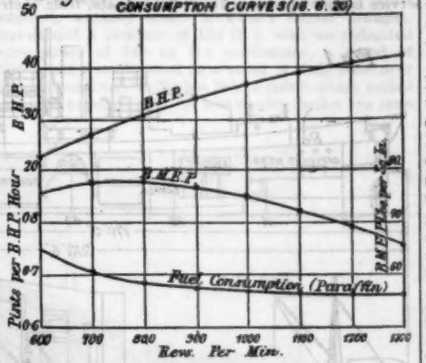


Fig. 22. TEMPERATURES OF WATER IN CYL^R JACKET HEAD & INLET (16.6.20) TEMP^S TAKEN DURING TEST D

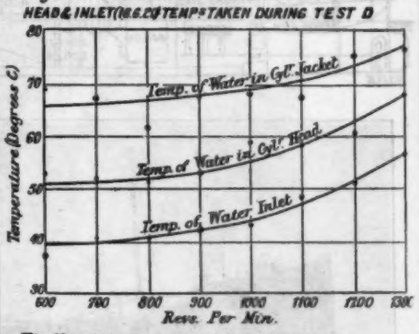
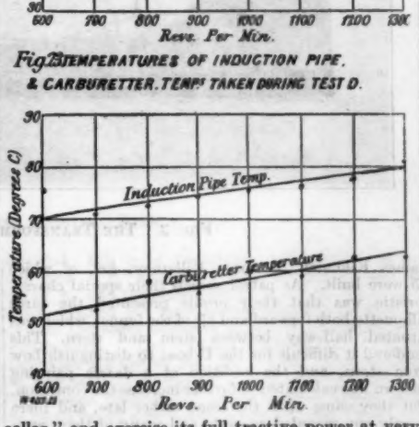


Fig. 23. TEMPERATURES OF INDUCTION PIPE & CARBURETTER. TEMP^S TAKEN DURING TEST D.



collar" and exercise its full tractive power at very low engine speeds will always give it advantages over the internal-combustion engine. In fact, for "breaking land" in the Colonies, where tree stumps, willow scrub, &c., have to be torn out, or other really heavy resistance has to be overcome at times, the ploughs hauled by traction steam engines will always make the better work, so much so that in the following year one can almost certainly tell which kind of tackle was used by the completeness with which the destruction of the previous growth has been accomplished. Traction engines were exhibited at the show by Messrs. Marshall, Sons and Co., Limited, of Gainsborough; Richard Garrett and Sons, Limited, Leiston; Charles Burrell and Sons, Limited, Thetford; Aveling and Porter, Limited, Rochester; J. and H. McLaren, Limited, Leeds; William Foster and Co., Limited, Lincoln; W. Tasker and Sons, Limited, Andover; Ransomes, Sims and Jefferies, Limited, Ipswich; Ruston and Hornsby, Limited, Lincoln; Clayton and Shuttleworth, Limited, Lincoln; and John Fowler and Co., Limited, Leeds; and possibly other makers. The above list is sufficient evidence of the vitality of the type, which ranges from the very large machines equipped for cable ploughing, as built by Messrs. Fowler and McLaren, down to the smaller tractors for road haulage. The steam road rollers shown by several of the firms named are merely a modification of the type. What actual power these traction engines develop we are unable to say, as their "nominal" ratings convey no meaning. The brake horse-power of the engines and the drawbar-pull developed at stated speeds, which are essential particulars for effective comparison are entirely wanting.

A four-wheeled agricultural tractor exhibited by Messrs. Peter Brotherhood, Ltd., Peterborough, was noticeable on account of the type of engine employed. This engine, which is illustrated in Figs. 17 to 20, on page 44, was built to the designs of Messrs. Ricardo and Co., Limited, of 21, Suffolk-street, Pall Mall, London, S.W. 1, and is a modification of the type which proved so successful in connection with the military "tanks." It has four cylinders, 4¼ in. bore by 5½ in. stroke, cast solid with the upper part of the crankcase, and develops 30–35 brake horse-power at 900 to 1,000 revolutions per minute. The special feature of the Ricardo engine lies in the form of the pistons. By reference to Figs. 17 and 18 it will be seen that a long trunk extends downward from the crown of each piston, these trunks carrying the usual gudgeon pin near their lower ends. The pistons and trunks are of aluminium, and around the lower part of each trunk a cast iron sleeve is fitted. This works in bored cast iron guides bolted to the main casting, which comprises both the cylinders and the upper part of the crank case. The lubrication of the gudgeon pins and of the crosshead guides is effected by the splash of the crank chamber. The air on its way to the carburettor passes round the ribbed exterior of the crosshead guides and tends to cool the latter. But the undersides of the pistons are also in communication with the air space by means of small ports formed in the upper flanges of the crosshead guides. There are also holes through the lower ends of the trunks and their surrounding sleeves, which give a restricted communication between the crank case and the undersides of the pistons. When the engine is working, therefore, fresh air and vapour from the heated oil are alternately drawn in and expelled from the space underneath the piston, and by this means the pistons are both cooled and lubricated. A special feature claimed for the design is the practical impossibility of the paraffin used as fuel finding its way into the crank case and spoiling the lubricating oil. Such paraffin as does get past the piston rings will either be carried through to the carburettor along with the air supply or will escape by means of the drain provided.

The details of the drive for the oil pump, magneto, &c., are shown in Figs. 19 and 20. A spur wheel on the crankshaft gears into a large idle wheel, the boss of which forms an eccentric. The eccentric strap carries the plunger of an oil pump of the type well known in connection with high-speed steam engine practice. The plunger reciprocates in a cylindrical casting, which has a rocking motion due to the movement of the eccentric. As the casting oscillates the ports connected with the plunger bore are made to communicate alternately with the inlet and outlet ports in the main fixed housing, and thus a simple and effective valveless pump is produced. The idler wheel driving the pump also gears into two smaller wheels, one keyed to the camshaft and the other to the governor spindle. The governor mechanism is clearly shown in Fig. 20. Ball bearings carry the spindle, and to the tail end of the latter the magneto is coupled.

The engine runs on paraffin, and requires petrol for starting purposes only. In Figs. 21 to 23, annexed, we reproduce diagrams showing the results of tests supplied by the makers, from which it will be seen that at the working range of speed the fuel consumption is about 0·675 pints of paraffin per brake horse-power our.

The shortage of agricultural labour during the last few years, and the energies of the Food Production

Department have given a great impetus to the development of the agricultural tractor, primarily for ploughing purposes, but at the same time for the haulage of self-binders, harrows, &c., and the driving of stationary machinery. The conditions which such a tractor has to meet are so varied, and in some respects so difficult, that it is hardly surprising that these machines have by no means settled down as yet along anything like standard lines of design. One can, however, perceive certain tendencies, which at any rate at the moment, appear to indicate the lines upon which development will take place. One would conclude, from the evidence of the show, that the chain-track or caterpillar tractor was low in public favour, machines of this type being exhibited only by the Martin Cultivator Company, Limited, of Stamford, and Messrs. Blackstone and Co., Limited, of the same town, both machines being of British design. We only noticed one three-wheeled tractor, the Glasgow, built by the Wallace Farm Implement Company, in the city from which its name is derived, and exhibited by the British Motor Trading Corporation, Limited, 50, Pall Mall, London, S.W. This tractor drives on all three wheels, and has many very interesting mechanical features to which we shall refer in the full description which we shall publish later.

The tendency of design appears to be in the direction of a four-wheeled machine, with the drive on the two hinder wheels. A four-cylinder vertical engine rated at from 20 brake horse-power to 30 brake horse-power is placed on the centre line of the vehicle, with its crankshaft longitudinal, and is situated in a fairly forward position. Even this engine arrangement is by no means universal, as sometimes the engines are fitted cross-ways. The wheel base ranges from under 6 ft. to over 7 ft., and the weight of the machine from 3,000 lb. to 5,000 lb. Whether the heavier or the lighter tractors will be more generally popular it is impossible to say, but there are certain points upon which most engineers conversant with agricultural work would agree. One of these is that many of the tractors have driving wheels far too small in diameter. The range of wheel diameter is now from about 39 in. to 60 in., and there can be no question that the larger the wheel the less injury the machine will do by packing the heavy wet clayey soils over which it will often have to travel in this country. The conditions on the prairies, where these tractors first came into use are entirely different to those obtaining in Great Britain, both as regards soil and climate, and this difference must be allowed for if the machines are to be successful.

In several designs, such as in the Austin, the British Wallis, the Fordson, &c., the "works" of the machine are well housed and protected, but this point is neglected or very inadequately attended to by several makers. The question of ground clearance and absence of fragile parts situated in danger of blows from large stones, stumps, &c., is often insufficiently considered. In one machine, the steering gear, of the motor-car type, had rods working inches below the front axle, and in imminent danger of destruction in the event of the machine passing over some raised obstacle. A further point for criticism is the apparent absence of consideration given to the question of the position of the driving pulley. This often seems to have been put on anywhere where the end of a shaft could be arranged to project from the machinery. As one of the great uses of a tractor is to drive stationary machinery, one would have thought that more attention would have been given to the best position of the pulley necessary for the purpose. The most usual place for it is at one side of the vehicle, the driven machine being located in front of the latter. Sometimes the pulley is tucked in somewhere between the large road wheel and the body, where a belt could hardly be got on it. At other times the belt would run dangerously near the front wheels, in fact, in one machine, it appeared as if the belt could not pass the front wheel at all if the front axle were in its normal level position. Another machine did not appear to have any belt pulley fitted, until one was discovered under the drivers' platform at the back. It is surely worth a little care to arrange the mechanism so that the belt drive can be taken off through a fairly wide angular range, and also so that the bell can be readily put on and the machine manœuvred easily into line with its work.

(To be continued.)

THE CONVERSION OF GUNBOATS TO CARGO VESSELS.

THE pressing call for cargo vessels of moderate dimensions has very naturally caused both shipowners and constructors to consider the possibility of utilising surplus navy craft by some means of conversion.

Of the numerous types of vessels constructed for auxiliary patrol and convoy service during the war, one type which is being adapted for mercantile cargo service is that known as the "Kil" boats, from their

Fig. 1.

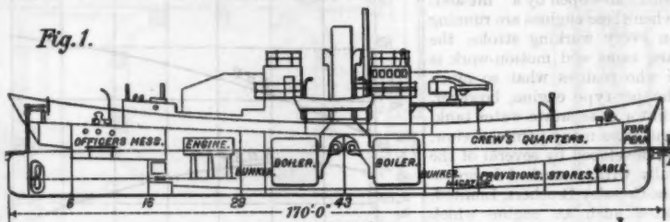
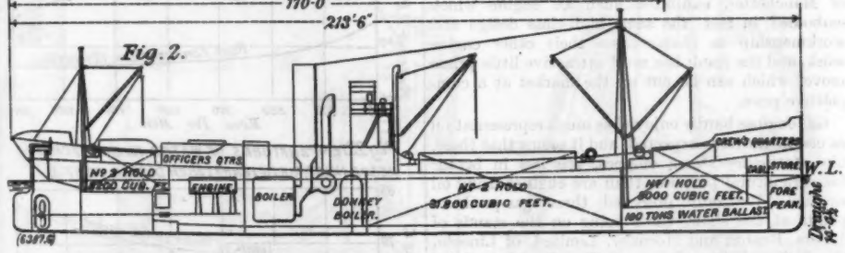


Fig. 2.



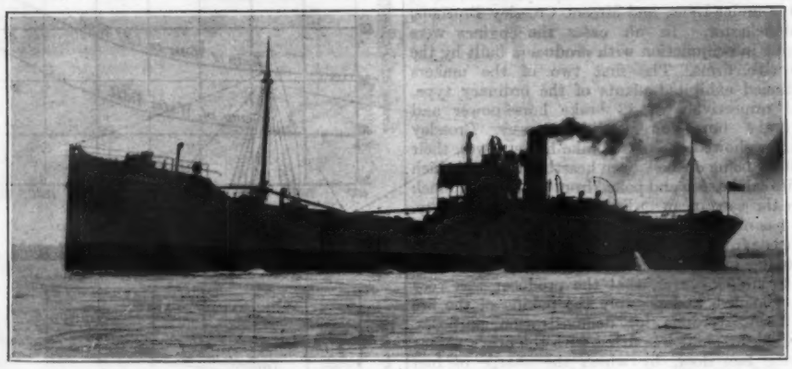


FIG. 3. THE TRANSFORMED KILDONAN ON TRIAL.

names Kildonan, Kilfinny, Killarney, &c., of which 55 were built. As patrol vessels their special characteristic was that their profile presented the same silhouette both forward and aft of the funnel, which was situated half-way between stem and stern. This rendered it difficult for the U-boat to distinguish bow from stern, and the addition of a dazzle painting pattern was calculated to further increase the confusion. But they came upon the scene rather late, and there is only one recorded as sunk, and many of them were practically new at the conclusion of hostilities. The simplest means of getting them into use for cargo carrying was to convert them without lengthening, but the advantages due to lengthening were realised.

Messrs. J. I. Thornycroft and Co., Limited, Woolston Works, Southampton, carried out the lengthening of vessels of this class, and the first of them treated in this way, the Kildonan, has lately completed her trials, and is now trading between the Channel ports for the Marlborough Steamship Company, Limited, Cardiff. The Kildonan as a gunboat is shown in Fig. 1, whilst Figs. 2 and 3 illustrate it transformed into a cargo vessel.

Some consideration of these lengthened ships is of special interest, and considering the rapidity with which the Kildonan has been completed and the increased carrying capacity attained, the venture presents all the appearance of being a successful one.

Their original length was 170 ft., the hulls being built under special survey by Lloyd's or the British Corporation, and the vessels were rated in the highest class of these societies for Government service. The construction was entrusted to firms accustomed to the building of large trawlers, and similar craft, but the greater number were built by the Smith's Dock Company, Limited, Middlesbrough, and Cochrane and Sons, Selby. The result of the conversion has been to produce quite a typical looking cargo steamer, 213½ ft. in length, with a deadweight cargo capacity of 950 tons to 1,000 tons, and retaining no trace of origin in outward appearance.

One boiler and stokehold has been eliminated, and the forward and after lower deck living spaces have been gutted out and converted into holds, the largest hold, No. 2, being obtained by cutting the vessel in the cleared boiler space and lengthening. The upper deck superstructure and gun platform all disappear, and is replaced by bridge deck and officers' quarters of new construction, following the usual cargo vessel plan. The rebuilding of the original bow, Fig. 4, results in a forecastle about 24 ft. in length forming the crew's quarters.

Two systems are being adopted by Messrs. Thornycroft for the cutting and lengthening process—one by putting the vessel into a dry dock, and the other by hauling up on a slipway. The latter operation is almost as spectacular as a launch, but lasts longer. It is, in fact, the reversal of a launching operation. The vessel is floated at high water over a cradle, and then hauled up by block tackles and winches on to the standing ways. The method of dividing the vessel is similar in both cases, requiring only the knocking out of rivets uniting shell plates and keel, no actual cutting being necessary anywhere. In dry dock, sliding ways have to be built up on which to haul apart the separated halves. After this separation careful observation is necessary to test the two halves for alignment. More especially is this the case with the vessels hauled up on the slipway, as it is almost impossible to ensure the ship settling absolutely true into the cradle. A certain amount of transverse adjustment was usually required after separation and was effected by the application of hydraulic jacks. The views, Figs. 5 to 8, on page 50, illustrate the hauling of a "Kil" boat up the slips, one of these boats hauled up, the halves of the Kildonan hauled apart in dry dock, and the altered stern of the latter boat.

In the vessels hauled up both boilers were first lifted out. In the ones dealt with in dry dock the discarded

boiler only was removed. The building in of the hull between the two separated halves of the ship is comparatively straightforward work, as the midship section runs parallel at this situation. There is more work involved in the far less conspicuous internal modifications carried on simultaneously. The bulkhead subdivisions undergo considerable change by the elimination of two cross coal-bunkers and by the forward shift of the bulkhead between No. 1 and No. 2 holds. The cargo vessel is divided into seven watertight compartments, viz., fore peak, No. 1 hold, No. 2 hold, stokehold, engine room, No. 3 hold and after peak. Beneath No. 1 hold a water ballast trimming tank has been built, and below No. 3 hold a watertight shaft tunnel accessible from the engine room, constructed and stiffened with angles and steel plates. Bilge keels, 9 in. deep, are also constructed for a length of 93 ft.

The time occupied by the Kildonan in dry dock was 75 days, the separating of the halves of the vessel taking place 12 days after docking, the operation itself taking less than 10 minutes.

The ships hauled up on the slipway can, with advantage, be retained there till the work is advanced considerably beyond the stage when they are floated out of dock, for the reason that the slipway is situated in close proximity to the workshops.

FIG. 4. ALTERING THE ORIGINAL STEM.

In the hull above water the rebuilding of the bow transforms the appearance of the vessel as much as anything, as can be seen from Figs. 3 and 8. The built-up forecastle is of the ordinary tramp type. At a time when the discussion about the danger of straight stems was going on, it might have been argued that the overhang was an advantage. The original object of this overhang was to give the bow the same outline as the counter stern. It has been done away with, the vertical stem having been carried straight up and the line of rail raised to give sufficient head-room in the forecastle. This change in the modelling of the bow is an interesting detail of the transformation scheme. The appearance of the stern is somewhat altered by slightly reducing the sheer of the rail, and covering the wheel with a turtle-back steel deck-house.

The three holds are of the following capacities: No. 1, 8,000 cub. ft.; No. 2, 31,800 cub. ft.; No. 3, 5,200 cub. ft. The arrangement of winches and derricks provides for two 3½-ton derricks to serve the after hold. The central derrick mast serves also as a cowl ventilator, the other two being mast derricks, Nos. 1 and 3 holds being provided with separate cowl ventilators. The deck openings to the holds are protected by steel coamings, 36 in. high, with pinewood covers supported on movable beams. The largest cargo hatch, No. 2, has an opening 46 ft. by 18 ft.

A very satisfactory feature about the transformed Kildonan is her accommodation plan. The saloon and captain's cabin run the full width of the vessel just forward of boiler and engine casing, and are not traversed by the alleyway, access being by a stairway from the chart-house on the boat deck immediately above. The alleyways on either side of the boiler casing give access to five cabins, a messroom, bathroom and pantry. Two of the cabins are single-berth and two double. The wheel-house, with pilot bridge, is built above the chart-room. The forecastle provides accommodation for six seamen and six firemen.

The result of the Kildonan's speed trial shows that the decision to remove one of the two boilers was thoroughly sound. The boilers were originally built to the classification society's highest requirements for 200 lb. working pressure, and on trial the single boiler retained, working under Howden's forced draught, maintained a pressure of 185 lb.; with an indicated horse-power of 648 at 114 revolutions, a speed of 11·6 knots was obtained as a mean of four runs over the measured mile in Stokes Bay, a result which rather exceeded expectations. A new donkey boiler has been provided; this is of Cochrane's vertical type, 14 ft. high and 7 ft. diameter. The heating surface is 500 sq. ft., and the grate area 26·75 sq. ft. The main boiler retained has been shifted about 6 ft. further aft into the space occupied by one of the eliminated cross-bunkers. The forward cross-bunker is also eliminated and thrown into No. 2 hold. This reduces the original coal stowage from 300 tons to 120 tons. The reduced consumption at lower speed should give the cargo vessel a radius of action of 2,500 miles.

The original engines remain unchanged, and are of an open-fronted type, entirely suitable for mercantile marine service. They consist of a single set of triple-expansion surface-condensing machinery built by Messrs. C. D. Holmes, Hull. The cylinders are 16 in., 26 in. and 44 in. diameter, respectively, with a stroke of 26 in. Piston valves are fitted to the high-pressure and mean-pressure cylinders, and Andrew and Cameron's balanced slide to the low pressure. The condenser, of the uniflux type, with its centrifugal circulating pump, is separate from the main engines. The propeller is a four-bladed right-handed single casting of iron, the pitch 11 ft. 6 in. and the diameter 9 ft. 8 in. The shafting is of best steel, the tailshaft being protected with a gunmetal sleeve. The auxiliary machinery comprises Weir's main feed pump, duplex auxiliary feed pump, Weir's air pump, duplex bilge pump. Steam steering gear is fitted at the after end of the engine casing. It is therefore readily seen that the whole machinery equipment is of unusually high-class for cargo work.

The cargo derricks are served by four 7 in. by 10 in. steam winches, the aftermost being fitted with extended ends for warping purposes. A steam windlass for working the anchors is provided on the forecastle deck, the cables passing through chain pipes into the locker. The anchor equipment consists of three stockless Bower anchors, two of them weighing 21¼ cwt. each and one 18 cwt., with kedge and stream anchors and 210 fathoms of 1⅛ in. stud link cable. Two 20-ft. lifeboats and a 16-ft. dinghy make a very ample boat equipment.

Other principal figures of the vessel as converted, not so far enumerated, are:—

Length between perpendiculars	213 ft. 6 in.
Breadth, moulded	29 ft. 10 in.
Depth, moulded	16 ft. 6 in.
Load draught (about)	14 ft. 4½ in.
Load, deadweight	950 tons to 1,000 tons.
Displacement at above draught	1,620 tons.
Speed, loaded	10 knots.

All the material and workmanship used in the conversion process are of the highest possible quality, and the completed ship creates a very favourable impression as a strong and seaworthy craft. It is classed 100 A.1 at Lloyd's.

The Kildonan will shortly be followed by other four "Kil" boats, similarly treated. Their performance should present some instructive figures, if comparisons could be made between them and the unlengthened ones. It is not claimed that an ideal cargo boat is produced, but the result is a surprising demonstration of what can be done by ingenious modification. One would not from her appearance suspect the completed vessel of having emerged from the distinctly peculiar "Kil" boat. The results of the trading of these transformed boats, and not their appearance, may call attention to a number of naval vessels of other types that still remain to be utilised.

INDUSTRIAL NOTES.

WITH reference to the Ministry of Mines Bill, of which we gave a short abstract on page 21 *ante*, a statement has been issued to the effect that beyond the salary of 2,000*l.* made payable by the Bill to the Minister of Mines, the establishment of the new Ministry is not likely to involve any substantial increase in expenditure, inasmuch as the majority of the powers of the new Ministry will be derived from the transfer of existing powers from other Government Departments, the concentration of which in a single department is one of the chief objects of the Bill. With the powers will be transferred the staffs of the other departments now engaged on the administration of the services to be transferred, *e.g.*, the staff of the mining department of the Home Office, and of the Coal Controller's Department. With respect to the extension of the continuance of the Coal Mines (Emergency) Act, 1920, it is not anticipated that the extension will involve the necessity for any additional advances from the Treasury to the account established under that Act.

The Ministry of Health announce that over 15,000,000 workers, men and women, besides almost all the employers of the nation, are affected by changes in National Health Insurance which came into force on Monday last. These changes, brought about by the National Health Insurance Act, 1920, are designed to bring health insurance more into line with the changed needs and economic conditions of the country. They alter the rates of money contributions payable and of benefits receivable, so as to bring them into closer relation to the lessened value of the £, and the higher cost of living.

Under the 1911 Act, the contribution payable in Great Britain was 7*d.* a week in the case of a man worker and 6*d.* in the case of a woman, of which amounts the worker's share was ordinarily 4*d.* for men and 3*d.* for women, the employer paying the remainder. On Monday, the 5th inst., the contribution payable became 10*d.* a week in the case of a man and 9*d.* in the case of a woman. The employer will normally contribute 5*d.* of the amount in each case, which means that the man worker will in future usually pay 5*d.* a week instead of 4*d.* and the women 4*d.* instead of 3*d.* In return for this increase in payments there will be a material increase in benefits. Thus, the amount payable to a man who is away from his work through illness will be 15*s.* a week, instead of 10*s.* as formerly; to a woman worker, 12*s.* a week instead of 7*s.* 6*d.* Disablement benefit will be 7*s.* 6*d.* a week in each case instead of 5*s.*, and maternity benefit 2*l.* instead of 30*s.*

The increases in benefits amount to, roughly, 50 per cent., whereas the penny a week increase in contributions payable by the insured person represents an increase of only 25 per cent. in the case of men and of 33⅓ per cent. in the case of women. They mark a change, therefore, in the direction of higher benefits in proportion to workers' contributions, a tendency which

may be even still further increased if, as is hoped, surpluses are disclosed in the valuation of Approved Societies now in progress. The societies, as was recently announced, have accumulated funds under the Act amounting to no less than 58,000,000*l.*, some small portion of which may become available for additional benefits for members of societies showing a surplus. The annual expenditure on benefits will in future become, it is estimated, nearly 30,000,000*l.* a year. The payments at present made during sickness represent a loss of "working-time" in Great Britain and Ireland of no less than 25,000,000 weeks a year.

The changes will involve the using of new stamps on the insurance cards of insured workers, and H.M. Stationery Office and the Government printers have been busy getting ready adequate supplies. The stamping of workers' cards at the new rates should be done promptly from last Monday, the 5th inst., because the law allows the deduction of the worker's share of the contribution from his wages only at the time wages are paid, and an employer failing to stamp at the new rates will subsequently have to make up the difference himself. Another point is that the stamping of cards which have fallen in arrears should be done at once, while the stamps for the old denominations, 7*d.* and 6*d.* are available. As post office stocks of the obsolete stamps become exhausted they will not be renewed, and these stamps will remain on sale for only a limited time.

Speaking last week in Sheffield at the annual meeting of Messrs. John Brown and Co., Limited, Lord Aberconway said the company obtained orders for goods upon which they put reasonable works' profits, and then before the contract had been a month in hand the price of coal went up or a strike came along, or they were faced by a demand for another 4*s.* a week, and those conditions took away the whole of the profit. They could not carry on business in conditions like that. Unless they had some settled condition of affairs in regard to cost of the materials and wages they could not take orders with a reasonable prospect of carrying them out with any satisfaction to themselves or to the persons who gave the orders. With the constant rises in wages and the consequent increases in the cost of living they were getting into a vicious circle which would soon end in the total destruction of trade. This must be stopped, or there would be no employment. People would not go on paying the high prices, and when the demand fell off wages would fall, and the development of the country would stop. Responsible trades union leaders recognised this, and he was glad to see that they were struggling against the demands of extreme minorities. The leaders were also against the half-hearted kind of work and slacking which only had the effect in the end of injuring trade unionism. British industry had a magnificent opportunity now of selling its commodities at good prices, if only these commodities were available for sale. The cost of shipping construction had gone to such a figure that orders had been kept back. Ships now cost something like four times the pre-war price. In the steel industry Germany was becoming a competitor in shafting, and America was always in a position to compete. America was constructing a large mercantile navy, and she was going to put navigation laws into force which would heavily handicap our ships in competition with hers. The high price of coal was becoming a most serious evil, and he hoped that the importance of not restricting output would be realised. They ought to appeal to the miners and every other class of workmen to think of others besides themselves, and, depend upon it, they would not suffer by taking a generous view of the economic situation, and regarding themselves as citizens of a great Empire, which was clamouring for their help. Let employers and employed join in fighting industrial difficulties and let them do it in a manner worthy of the great British race.

The Parliamentary Committee of the Trades Union Congress met last week to consider the report of the Special Trade Union Co-ordination Committee, which they adopted; it will be presented to the Congress at Portsmouth in September. Instead of the Parliamentary Committee, it is proposed to have a Trade Unions Congress General Council, with administrative departments under the joint control of the Congress, the Labour Party and the co-operative movement. The proposed trade groups are: (1) Mining, railways and transport; (2) shipbuilding, engineering, iron and steel, and building; (3) cotton, other textiles, clothing, and leather; (4) glass and pottery, distribution, &c., agriculture, and general workers; (5) printing, public employees, and non-manual workers. The standing orders for the new body are given as follows:—

(*a*) The General Council shall keep a watch on all industrial movements, and shall attempt where possible to co-ordinate industrial action.

(*b*) It shall promote common action by the trade union movement on general questions, such as wages and hours of labour, and any matter of general concern that may arise between trade unions and employers or between the trade union movement and the Government, and shall have power to assist any union which is attacked on any vital question of trade union principle.

(*c*) Where disputes arise or threaten to arise between trade unions, it shall use its influence to promote a settlement.

(*d*) It shall assist trade unions in the work of organisation and shall carry on propaganda with a view to strengthening the industrial side of the movement and for the attainment of any or all of the above objects.

(*e*) It shall also enter into relations with the trade union and Labour movements in other countries with a view to promoting common action and international solidarity.

Further, branches would be formed for research, legal advice and publicity.

To provide the necessary income, the question of basing the affiliation fee to Congress on a sum per member is to be considered, it being pointed out that an affiliation fee representing 1*d.* per member of the unions affiliated to the General Council would, on a 6,000,000 affiliation basis, produce an annual income of 25,000*l.*

A settlement has been arrived at in the printing trade dispute following a ballot taken last week of members of the Typographical Association. The votes were counted in Manchester and afterwards the following statement was issued:—

"The Federation of Master Printers received from the Typographical Association at Manchester this afternoon (the 1st inst.) a message to the effect that the offer of 10*s.* and the employers' terms regarding the further conference when the Rent Restrictions Act becomes operative have been accepted by a fairly large majority. Notifications have been issued to the Local Master Printers' Associations to inform all employers of the decision, and asking them to arrange for payment of the increased wage for the past three weeks and the current week.

"Owing to the short notice it may not be possible in all cases for the additional wages to be paid this week, but they will, of course, be adjusted in next week's payments."

The employees of the London Metropolitan Water Board, numbering about 4,000, met last Saturday, and decided to give the Board a week in which to decide to grant their demand for a 4*l.* a week minimum.

The annual conference of the Miners' Federation of Great Britain opened at Leamington last Tuesday, under the chairmanship of Mr. R. Smillie, who, after speaking for the nationalisation of the mines, said there had been no necessity for the recent increase of the price of household coal by 14*s.* 2*d.* per ton. He stated that the Government were in a position to reduce the price of coal by this amount and to give the miners a considerable increase in wages, the coal industry remaining still, as a whole, a paying proposition. It would not be unfair for the miners, Mr. Smillie added, to demand either that householders should be relieved of this very large increase, or that the miners should claim in increased wages "the whole available balance." In his computation the removal of the 14*s.* 2*d.* per ton would cost 36,000,000*l.*, reducing the cost of living to that extent; there would then be a surplus of 29,500,000*l.* available for wages. That surplus was now going into the National Exchequer. The miners had not yet reached, he further stated, a position in which they were able to face the increased cost of living, and the Exchequer was not entitled to take the money from the industry until the miners were able to face it. It is understood that the Executive have put forward a claim for a flat rate increase of 2*s.* per day for adult workers and 1*s.* for workers under 16, coupled with a reduction of 14*s.* 2*d.* in the price of coal.

The dispute in the gas industry was settled last Tuesday at a conference which was held at Essex Hall, London. The terms agreed upon include the payment of an advance of 1*s.* per day or per shift from and including May 1, 1920; the provision of holidays at plain time rates according to time of service of the men and to the number of men employed in the undertaking; payment for work on Sundays at the rate of time and a half, with certain provisions. The men demanded an advance of 10*s.* per week.

HIGGS BROTHERS' MAGAZINE.—We have received from Messrs. Higgs Brothers, Dynamo Works, Birmingham, the July issue of their magazine, a handy booklet measuring 5¼ in. by 4 in., which gives in tabular form, particulars of some of the dynamos they build, showing those in stock, power, speed, &c.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The reaction which has been noticeable in the iron and steel trade of the district during the past few weeks has become more pronounced. The general downward tendency has set in not only in the home but foreign markets, and whereas a few months ago makers were turning down heavy orders, many companies are now discharging hands in consequence of the shortness of work. Buyers generally are holding off for lower prices, but with wages and costs still on the up grade manufacturers find themselves between the upper and nether millstone, and take a decidedly pessimistic view of the immediate future. In finished steel prices are easier. Considerable quantities of American material are being offered both here and on the Continent at rates which compare favourably with local producers. In the engineering branches restricted production has had an even more depressing effect than the high prices prevailing. Important contracts have been held up for want of castings. The evil effects of the moulders' strike are still being felt, and the heavy arrears which then accumulated are responsible for much of the delay. The iron market shows no signs of easing down. Blast furnaces continue at full work, but their output is far below the needs of the country, and prices remain exceedingly high. Business in several important classes of hand tools is also well maintained, and some of the heavy engineering branches keep up a steady output. Stock-taking has been general at the works during the past few weeks, and buying having been necessarily suspended has had a still more depressing tendency. With trade resuming its normal course, the future, it is hoped, will present a brighter outlook.

South Yorkshire Coal Trade.—The position with regard to the coal trade has undergone little change during the past week. The output at the pits has somewhat improved, and the demand for coal of all descriptions is well maintained. Steam fuel, owing to the export restrictions, is in better supply, but the shortage is still acute. Best steam hards are in strong request by all classes of home consumers. Railway companies and manufacturers generally are anxious to build up their reserves, and in some cases have been successful in adding to stocks. The whole output is readily taken up at full rates. Cobbles, nuts and slacks are all firmly held by contractors, and there is practically nothing on the open market of any of these qualities. Melting cokes are difficult to obtain even at the high prices they are now fetching. For house coal the demand is still on the light side. The arrears on merchants' orders have been practically overtaken, and there is now a favourable opportunity of laying in winter stocks. In view of the uncertainty as to the action of the miners, the public, however, do not seem anxious to stock their cellars at present prices. Quotations:—Best branch handpicked, 37*s.* 2*d.* to 38*s.* 2*d.*; Barnsley best Silkstone, 37*s.* 2*d.* to 37*s.* 8*d.*; Derbyshire best brights, 35*s.* 2*d.* to 36*s.* 2*d.*; Derbyshire house coal, 32*s.* 8*d.* to 33*s.* 2*d.*; Derbyshire best large nuts, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire small nuts, 31*s.* 8*d.* to 32*s.* 8*d.*; Yorkshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; rough slacks, 28*s.* 2*d.* to 29*s.* 2*d.*; nutty, 27*s.* 2*d.* to 28*s.* 2*d.*; smalls, 23*s.* 2*d.* to 24*s.* 2*d.*

FAIRFIELD ENGINEERING AND SHIPBUILDING COMPANY, LIMITED.—It is announced that Mr. Alexander M. Kennedy, managing director of the Northumberland Shipbuilding Company, has been appointed managing director of the Fairfield Shipbuilding and Engineering Company, Limited, Glasgow, in succession to Sir Alexander Gracie, whose retirement we announced last week. Mr. Kennedy will retain his position as managing director on the Board of the Northumberland company.

MACHINE TOOL AND ENGINEERING EXHIBITION.—The Machine Tool and Engineering Exhibition which will be held at Olympia from September 4 to 25, was to have been held in 1916, but on account of the war it has been postponed until this year. The first exhibition was held in 1912, and the fact that eight years have elapsed since the last exhibition of machine tools in this country will mean that more new models and new types will be on view than have ever been shown at any previous exhibition. The number of separate exhibitors will exceed 200. The exhibition is being organised by the Machine Tool Trades Association, 70, Victoria-street, S.W. 1, of which nearly all British machine tool manufacturers and merchants are members.

SHIELD FOR ENGINEERING APPRENTICES.—Some few years ago the London Association of Foremen Engineers decided to offer a shield for annual competition amongst lads working in establishments employing members of the association, but owing to the war the scheme was held up until last year, when the first competition took place. Records of the lads' work and conduct in the shops are forwarded to the association at stated periods by the foremen themselves, and after careful comparison at the end of the year the winner is selected. The first apprentice to have his name inscribed on the shield is Arthur H. Skinner, who works in the tool-room of the Engineer's Department of the India Rubber, Gutta Percha and Telegraph Works Company, Limited, Silvertown. Both the lad and his employers are to be congratulated on the distinction. The shield is held for one year by the company, and the lad receives a gold miniature and 3*l.*, which must be spent in an approved manner. In this instance technical books were bought. The scheme will doubtless be a great incentive to the lads, and is certainly a step in the right direction.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Cleveland pig-iron is still very scarce, but there is some prospect of a change in the situation. Output may shortly be increased by the blowing in of one or two idle furnaces, and it is reported that in some quarters pressure for delivery under current contracts is much less insistent. At the same time any parcels that come on the market are promptly snapped up. Producers continue to adhere to their decision not to sell for abroad, but there are reports that Japan is offering some of her purchases for sale on the Continent. A parcel of 10,000 tons of Cleveland pig-iron recently imported to Japan is stated to have been offered to Italy. For home consumption, No. 3 and the commoner kinds of Cleveland pig-iron are 230*s.*, and No. 1 is 217*s.* 6*d.* There are no export quotations.

Hematite Iron.—There is no new feature in the hematite branch. Most makers are as fully sold as they wish to be, but in addition to the limited home trade passing occasional odd parcels can be bought for shipment abroad. For home purposes, Nos. 1, 2 and 3 are 260*s.* and No. 1 is 262*s.* 6*d.*; and for despatch to France, Belgium and Italy, mixed Nos. are 265*s.* and No. 1 is 267*s.* 6*d.*; whilst up to 275*s.* is named for hematite export to neutrals.

Foreign Ore.—Business in foreign ore is practically at a standstill. After the lengthy period of inactivity sellers are beginning to show anxiety to enter into contracts, but consumers hold off the market in the confident belief that movement will continue in their favour. Orders for delivery to the end of the year could be placed on the basis of 49*s.* for rubio, of 50 per cent. quality, on the 17*s.* parity freight, Bilbao-Middlesbrough, so that as charterings from the Spanish ore port have dropped another shilling, to 25*s.*, the c.i.f. Tees value of best rubio becomes 57*s.*

Coke.—Coke keeps strong and in good demand on both home and foreign account. Medium blast-furnace kind is 62*s.* 9*d.* at the ovens, low phosphorus sort is 65*s.* 3*d.*, and foundry quality is 70*s.* 3*d.* for home use. For export both foundry and gas-house coke are quoted up to 200*s.*

Manufactured Iron and Steel.—Finished iron and steel producers are very full of work, and values are maintained, but there is little new business passing. Some home buying of certain descriptions of steel is reported, but Continental demand shows marked falling-off. A disquieting feature is the threatened further cancellation of shipbuilding orders, and increasing American and Belgian competition is disturbing. The following are among the principal market quotations:—Common iron bars, 30*l.*; marked bars, 32*l.*; iron angles, 30*l.* 15*s.*; rivets, 38*l.*; steel ship, bridge and tank plates, 23*l.* 10*s.*; steel angles, 23*l.*; steel joists, 23*l.*; soft steel billets, 25*l.* 10*s.*; hard steel billets, 26*l.* 10*s.*; heavy sections of steel rails, 23*l.*; fish plates, 28*l.*; black sheets, 44*l.*; corrugated galvanised sheets, 54*l.* to 56*l.*

Shipments of Iron and Steel.—Of the 56,159 tons of pig-iron shipped at the port of Middlesbrough during June, 32,790 tons went coastwise, and 23,369 tons went to foreign ports, the principal customers being Scotland, 24,910 tons; Belgium, 8,636 tons; Wales, 4,490 tons; France, 4,005 tons; Italy, 3,740 tons; and the Tyne, 2,490 tons. Java, with an import of 851 tons, was the largest receiver of the 2,923 tons of manufactured iron despatched, 650 tons of which went coastwise, and 2,273 tons foreign. Of the 20,096 tons of steel cleared, 3,377 tons went coastwise, and 16,719 tons went abroad, the largest receivers being India, 4,206 tons, and Portuguese East Africa, 3,267 tons.

THE SYNTHESIS OF AMMONIA.—In the *Bulletin de la Société pour l'Encouragement de l'Industrie Nationale* of February last, Marcel Guichard, Vavon and others gave an account of their war-time researches on the synthetic preparation of ammonia from nitrogen and hydrogen, and especially on the metallic catalysts which they used in the Haber process. They particularly experimented with metals of the iron group which are not readily oxidised by water vapour in the presence of an excess of hydrogen, leaving the easily-oxidisable metals of the alkalis and alkaline earths as less suitable, because they would require a complete drying of the gas mixture. The experiments were made with tubular electric furnaces of steel at temperatures up to 750 deg. C. In most cases a temperature near 600 deg., generally a little below 600 deg., was found most efficient. They tried some 400 metals and metal-mixtures or alloys, and found in ferro-molybdenum one of the best. This alloy was prepared, either by dissolving ammonium molybdate and iron nitrate together in water, evaporating the mixture and reducing the salt by means of hydrogen, or by precipitating the acid mixture of these two salts and by reducing the dried precipitate at 1,000 deg. C. With this alloy they obtained the highest ammonia concentration, of 4 per cent., whilst iron and molybdenum alone gave only 1 per cent. and 1·5 per cent. Of single metals nickel and cobalt proved equally efficient, the ammonia concentration reaching 3 per cent. Uranium alone also gave good yields, in the perfectly dry gases, but alloyed with nickel or tungsten it proved a poor catalyst. On the other hand the life of the catalysts was decidedly prolonged by mixing them with 50 per cent. of magnesia; this applies particularly to nickel, cobalt, iron, tungsten and molybdenum; nickel and cobalt mixed with 20 per cent. of alumina also answered. The furnaces were worked at pressures of 100 atmospheres, sometimes 150 atmospheres.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—Active conditions are general in the steel trade of Scotland at present, and pressure for deliveries before closing down for the holidays next week is being exerted by consumers. Raw material is scarce, and steel-makers are faced with a probable further shortage in the near future, which may be a serious matter, as supplies have not been nearly sufficient for their requirements for some time back. The demand for ship and boiler plates has not lessened despite the cancelling of certain orders for new tonnage with Clyde builders, nor is there any anticipation of a falling-off in the meantime unless the wages question of the workers goes against the masters. In that case, the whole position of things will require to be carefully considered, as prices have already reached a point beyond which profitable business is wellnigh impossible. With ship plates, &c., so costly, labour so dear, and freights tending downwards, there is bound to be a slump in shipbuilding. Sectional material is still fairly active, and makers have been doing a very satisfactory business of late. Black sheets are a particularly active part of the steel trade, and there is at present, and has been for some time, a very large output from the various works. The heavy bookings of months past are only being slowly worked off, and at the present rate it will be many months yet before producers get level with their order books. In this branch of the trade the outlook is bright and no clouds keep hovering around to cause doubt and uncertainty. A good business is passing in galvanised sheets.

Malleable Iron Trade.—The malleable iron trade in the West of Scotland continues on fairly steady lines, and works are all busy. Much stuff is being asked for during the next week and producers are quite unable to cope with all the requests, and part deliveries can only be given before the holidays. The general position is practically unchanged, and prices continue firm, with "crown" bars called 30*l.* per ton for home delivery. Export business is very quiet.

Scotch Pig-Iron Trade.—The heavy demand and the continued great scarcity of all grades are the outstanding features in the Scotch pig-iron trade just now, and these are not only conditions of a temporary nature, but the immediate future holds out little prospect of any improvement. The output from the different works is a long way short of the amount required by consumers of foundry iron and hematite, and a system of dividing up supplies is general. The steelmakers have been getting such inadequate deliveries of hematite that their output has suffered considerably, but the producers have been doing everything possible to maintain the output of hematite, though the shortage of raw material must be held mainly responsible for the present trouble. A small percentage of foundry iron has been earmarked for shipment, but 16*l.* 10*s.* per ton for No. 1 grade, and 10*s.* less per ton for No. 3 grade is not very tempting to foreign buyers.

The Annual Holidays.—The annual Fair Holidays in Glasgow and the surrounding district commence on Thursday afternoon of next week, when operations will cease in the various industries for at least a full week, although many of them will not be restarted until Monday the 27th. In the Greenock and Port Glasgow district the holidays are just finishing, and by Monday first the engineering shops and shipbuilding yards on the lower reaches of the Clyde should again be working. A change was recently made in the annual trades holidays in Edinburgh district, and this week the workers in the capital are on holiday—the first full week of July. The time was, and not so many years back at that, when labour was content or perhaps had to be so, with only a few days' respite from work at this time of year, in many establishments it really consisted of a glorified week-end, but now it is very different and the minimum vacation is a full week carrying pay with it in most industries.

Clyde Navigation Trust.—Some interesting particulars relative to the financial position of the Clyde Navigation Trust were given by the chairman, Sir William Raeburn, M.P., at a meeting of the trustees yesterday. He stated that for the first time in the history of the Trust the revenue for the year reached seven figures. The year which closed on June 30 showed a total revenue of 1,077,940*l.* 17*s.* 6*d.*, an increase over last year's total of 190,694*l.* 17*s.* The expenditure had also greatly increased, and it could not be said at the present moment what the surplus revenue would be. Last year it amounted to 74,000*l.* odd, and they were in hopes that this year the surplus would reach 100,000*l.* The budget would be submitted to the trustees at their meeting in September. In face of the fact that so many ports were in an uncomfortable position with regard to revenue, the Trustees might congratulate themselves. It was impossible to say how shipping might go during the next year or so. The outlook had many anxious features, but he believed that there would be an increase in the traffic at the harbour, both inward and outward.

SHIPBUILDING IN GERMANY.—According to German admissions, says *The Marine Journal*, New York, Germany is in a position to turn out 700,000 gross tons of shipping annually. Professor Laas, of the Technical University, addressing the Shipbuilding Technical Society, gave this figure. He pointed out that after deducting the 200,000 tons which would be due annually to the Entente for a period of five years, there was a possibility of replacing Germany's lost cargo space in about eight years. "There is a sufficient number of orders at present," he added, "and the principal need is a greater output by the workers."

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Markets.—Operators are still experiencing much difficulty in carrying on their business as the quantity of coal available for export as cargo is considerably under the requirements of foreign consumers and the allocations to individual collieries inadequate to meet the demands of shippers. In fact, many collieries after supplying a portion of their contract quantities have nothing for disposal on the open market, and consequently buyers with contracts in a number of instances are compelled to go on the market and buy at current prices which are round 115*s.* for all descriptions of large and 95*s.* for smalls. It is practically impossible to get a decent-sized cargo together without taking parcels from 20 or more collieries, and the formalities to be gone through have created a considerable amount of extra clerical work. In one instance 70 permits of 10 tons each were necessary for a cargo of 700 tons, presumably because the colliery company were not supplied with permits of higher denomination, and as each of these permits has to give particulars of six different items it is obvious that this involves extra clerical work on the collieries and exporters. These formalities have been further increased by a requirement that in future all tipping orders must be endorsed by dock inspectors appointed to see that shipments are carried out in conformity with pre-entries and so safeguard against evasions of the limitation scheme. This is likely to delay shipping, for it often happens that through unforeseen circumstances a vessel at the last minute may be short of her cargo to the extent of 20 tons or more. Under ordinary conditions it was usually possible to arrange to complete with coals standing on the dock, but now it is necessary to put a pre-entry through and get a tipping order endorsed before the dock company can load the coal. This will take at least 24 hours, though arrangements have been made to consider supplementary pre-entries. The demand for bunkers for vessels proceeding foreign has eased off considerably, and many collieries are under-shipping their bunker allocations despite the fact the such allocations have been reduced by 9 per cent. and the quantity added to the cargo allocations. In the circumstances it is expected that there will be a further reduction in bunker quantities and a corresponding increase in available cargo shipments which should benefit exporters and the trade generally for current price of cargo, large is 115*s.*, compared with 90*s.* for bunker large. The inland demand locally is not sufficient to absorb colliery outputs, though there are inquiries from other districts, but collieries are reluctant to put in their own wagons for this business, and as consumers in most cases are unable to supply trucks some consumers are still short of supplies, not through a lack of coals or readiness on the part of collieries to supply, but through inadequate transport facilities. At the same time many collieries are experiencing much difficulty in keeping their pits going because of the restriction in exports.

The Iron and Steel Trades.—Unsettled conditions still prevail in the tin-plate market, and lately there has been a number of cancellations of orders and re-sales. At the moment foreign buyers appear to be pretty well covered, and there is practically no inquiry from the Far East. On the other hand makers mostly are fully booked up with orders and prices are steady at 66*s.* to 68*s.* for standard boxes.

ASSOCIATION OF CONSULTING ENGINEERS, INCORPORATED.—This association, whose offices are at 11, Victoria-street, Westminster, has issued its committee report for the twelve months ending April 30 last, together with its professional rules and practice, and scale of fees.

FOREIGN TRADE OF ARGENTINA.—Information reached Buenos Aires from New York a short time ago, says the British Bank of South America, Limited, of the formation of an Argentine-American banking institution, it being stated that it would have as its object the facilitating of reciprocal banking and commercial relations between the two countries, and particularly the advancing of money on goods imported and exported.

INTERNAL-COMBUSTION ENGINE SLIDE RULE.—We have received from the Cavendish Press, Cheam, Surrey, a slide rule designed by Mr. V. B. Harley-Mason, A.M.I.C.E., especially for the use of those engaged in the design and operation of internal-combustion engines. The scales on the rule proper are the ordinary logarithmic scales, but those on the slide have been worked out so as to enable all calculations relative to the horse-power, mean effective pressure, piston speed, bore, stroke, &c., of an internal-combustion engine to be determined with a minimum of trouble. The rule can be obtained from the Cavendish Press at the address already given. The price is 7*s.* 9*d.* post free.

BRITISH CHEMICAL STANDARDS—IRON AND STEEL.—In one of our former issues (see vol. cv, page 374), we gave under this title particulars of a scheme set on foot by Messrs. Ridsdale and Co., Laboratory and Technical Bureau, Middlesbrough, for the preparation of chemical standards of iron and steel. A report on the first three years' working of the scheme, from September, 1916, to September, 1919, has now been issued by the organisers, 3, Wilson-street, Middlesbrough; it gives information on the movement, its object, the names of the contributors, details of the standards prepared and accounts of the meetings of the co-operators, with the resolutions passed at these meetings.

THE CONVERSION OF GUNBOATS TO CARGO VESSELS.

BY MESSRS. J. I. THORNYCROFT AND CO., LIMITED, SHIPBUILDERS, SOUTHAMPTON.

(*For Description, see Page* 46.)

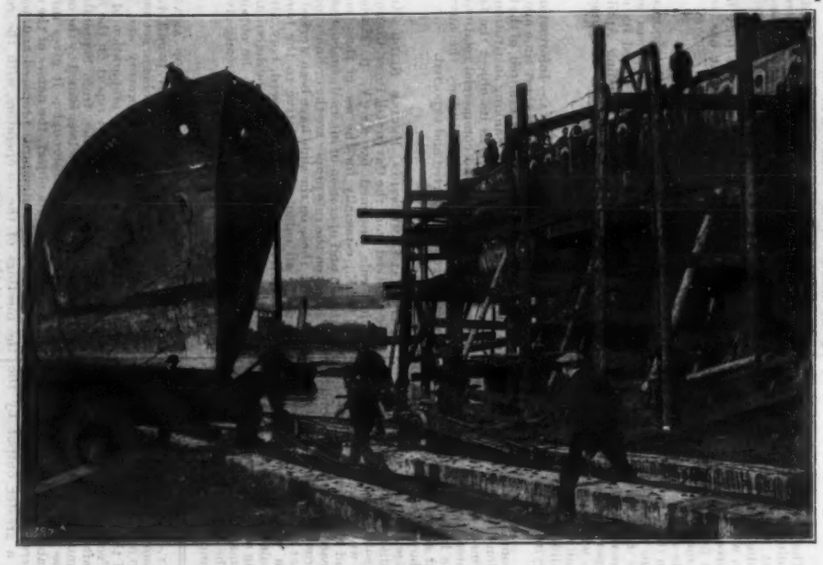


FIG. 5. HAULING A "KIL" BOAT UP THE SLIPS.

FIG. 6. A "KIL" BOAT HAULED UP PREPARATORY TO BEING BISECTED.

FIG. 7. THE HALVES OF THE "KILDONAN" HAULED APART IN DRY DOCK.

FIG. 8. THE ALTERED STEM OF THE "KILDONAN."

THE LINCOLN WORKS OF MESSRS. RUSTON AND HORNSBY, LTD.; THE NAVVY WORKS.

(*For Description see Page* 33.)

FIG. 27. ERECTING BAY.

FIG. 28. ERECTING BAY.

(*To face page* 34.)

STEAM NAVVIES.

CONSTRUCTED BY MESSRS. RUSTON AND HORNSBY, LIMITED, ENGINEERS, LINCOLN.

(*For Description see Page* 33.)

FIG. 29. FIVE-TON STEAM NAVVY.

Fig. 30.

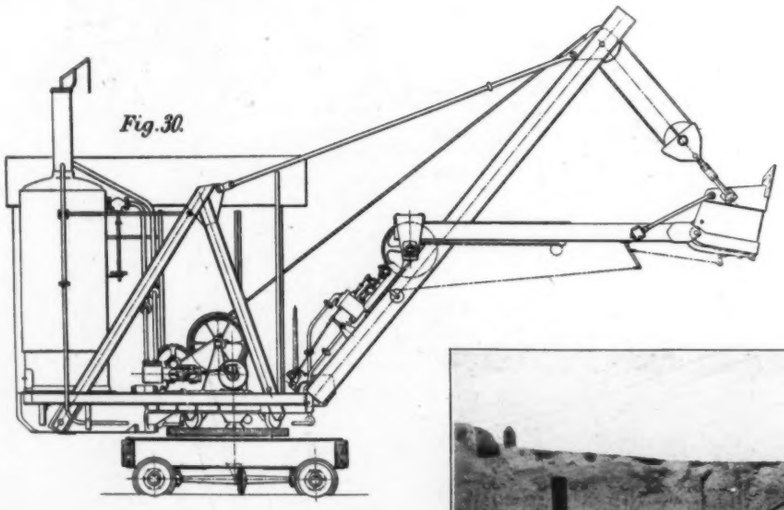


Fig. 31.

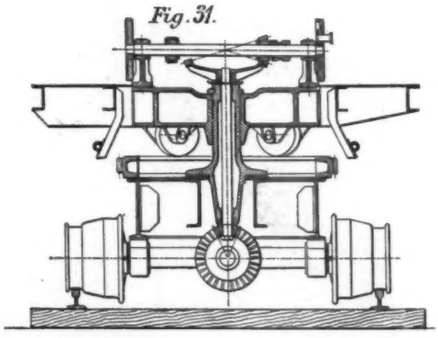


Fig. 32.

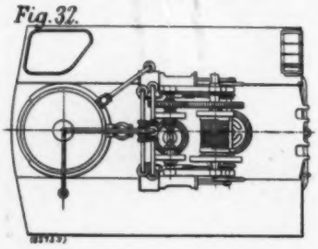
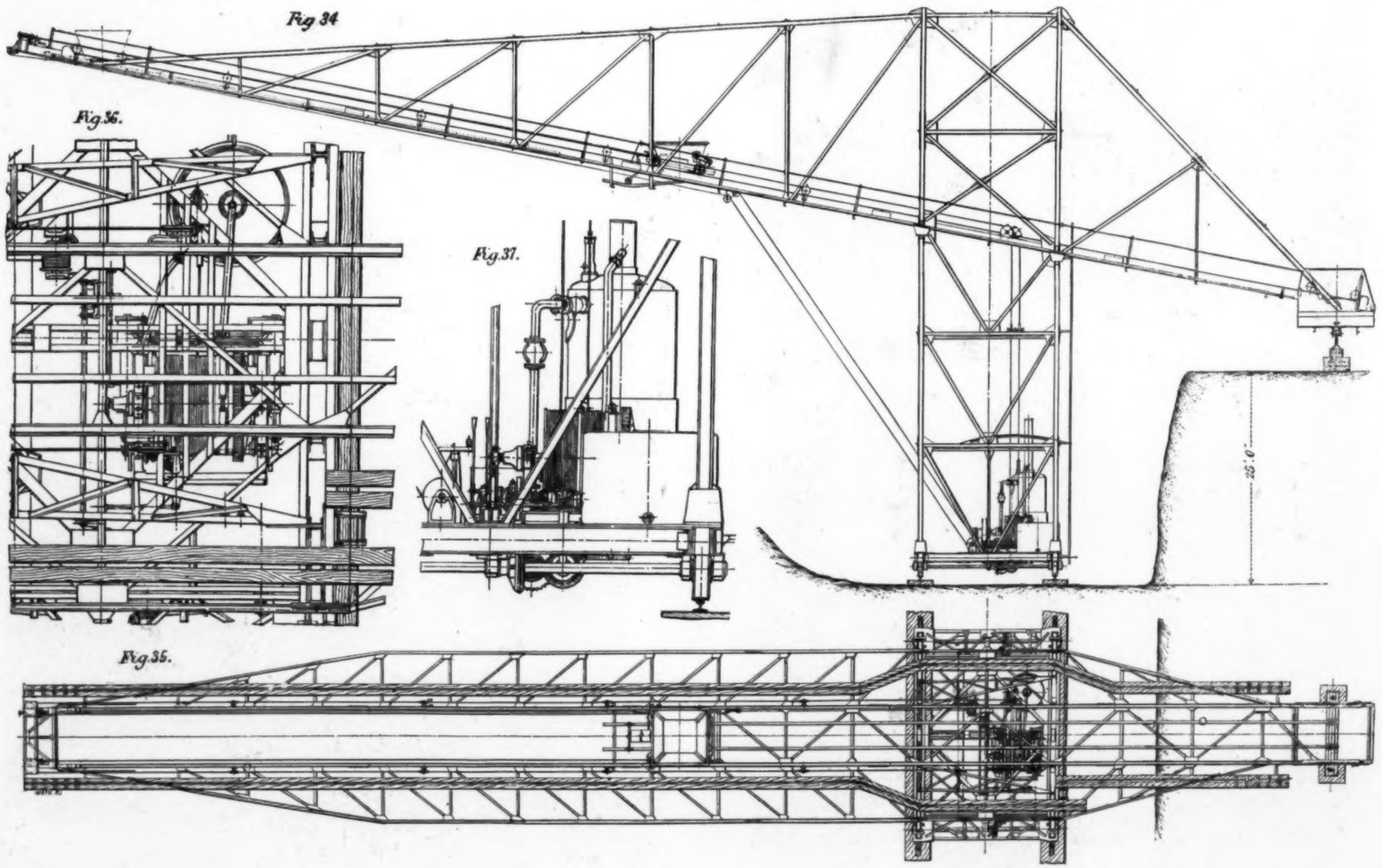


FIG. 33. NAVVY EXCAVATING CHALK.

TRANSPORTER FOR USE IN CONNECTION WITH STEAM NAVVY.

CONSTRUCTED BY MESSRS. RUSTON AND HORNSBY, LIMITED, ENGINEERS, LINCOLN.

(*For Description see Page* 33.)



THE LINCOLN WORKS OF MESSRS. RUSTON AND HORNSBY, LTD.; THE MOTOR CAR WORKS.

(*For Description, see Page* 33.)

FIG. 41. THE RUSTON HORNSBY CAR ERECTING SHOP.

FIG. 42. MACHINE SHOP FOR MOTOR CAR PARTS.

(*To face page* 35.)

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AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Angus and Robertson, Limited, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia. Melville and Mullen, Melbourne, Victoria.
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TASMANIA: Gordon and Gotch Proprietary, Limited, Launceston: Hobart.
UNITED STATES: For Subscriptions, New York: W. H. Wiley, 432, Fourth Avenue. For Advertisements, J. S. Allan, 30, Church-street, New York.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12s. per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

SUBSCRIPTIONS, HOME AND FOREIGN.

REVISED RATES.

"ENGINEERING" may be ordered from any newsagent in town or country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom	£3 3 0
For Canada—	
Thin paper copies	£3 18 6
Thick ,, ,,	£3 3 0
For all other places abroad—	
Thin paper copies	£3 3 0
Thick ,, ,,	£3 7 6

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "The National Provincial and Union Bank of England, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford Street, Strand, W.C. 2.

Offices for Publication and Advertisements 35 and 36, Bedford Street, Strand, London, W.C. 2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.

TELEPHONE NUMBERS—3663 and 8598 GERRARD.

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With Four One-Page Plates of the LINCOLN WORKS OF MESSRS. RUSTON AND HORNSBY, LIMITED.

NOTICE.

A few months ago the Proprietors of "ENGINEERING" were compelled to advance the price of this Journal to 1s. per copy, owing to the enormous increases in the cost of paper, engravings and printing, &c. Now higher transport and delivery charges involve a further increase to 1s. 2d. per copy, and this price dated from and included the issue of Friday, April 2, 1920. So long as postal rates remain as at present there will be no increase in the price of copies sent by inland post, which will continue at 1s. 2d. post free.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions still imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents will not have copies for chance customers; therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

ENGINEERING.

FRIDAY, JULY 9, 1920.

INCREASING WAGES AND THE EFFECT ON TRADE.

FOLLOWING on the cessation of hostilities, almost every industrial concern immediately reached the position of being flooded out with orders to replace the wastage of war, and to make good the unusually great depreciation caused by the 4½ years of war work incessantly pursued to the almost total exclusion of all normal effort. Furthermore, due to the extraordinary strides of science consequent upon the intensity of inventive research, fostered by war conditions, there was a wide demand for new products, resulting from the altered conditions. Inflated currencies, and the consequent reckless feeling of false prosperity engendered, led to augmented spending. The war time suspension of unemployment, and the effects of the demand for labour always exceeding supply, led, not only here but elsewhere, to the temporising, compromising and conciliatory policies adopted by Governments chiefly concerned with the conduct of hostilities, and anxious, at even very considerable cost, to ensure that, at least, a united front should be presented at home. The result was, that the great mass of the workers found themselves, at the end of the war, in a position of greater prosperity in regard to powers of spending than has ever before been the case. It will not be gainsaid, too, that in many instances improvements on the standard of life economically possible before the war were very considerably overdue, and that the pre-war conditions in certain quarters were discreditable, and, in the long run, even distinctly unprofitable. The definite statement must be made, however, that at the date mentioned the standard reached was the highest of all industrial history.

What, then, is the position to-day? During the last eighteen months, there have been granted to labour, advances in wages greater in proportion to the increasing cost of the necessities of life than at any previous period. In such calculations the shorter working week, operative in many trades and without loss of weekly earnings, must be included. In some cases these recent advances in wages were given by the Government or through its agencies, in others they were obtained by the usual and well-known methods; either through official and recognised channels, or by unofficial methods and sectional strikes. The position to-day is, that during the last eighteen months, advances, totalling on the average over 20 per cent. above the war wages, have been given. It is not the purpose of this article to dilate upon the reaction of increasing wages upon the cost of living and *vice versa*, but rather to point out the inevitable consequences of a pursuance of the present policy.

The many orders placed as soon as possible after the armistice, were necessarily—owing to the fluctuating and unstable conditions—either on a "time and line" basis, or contained such clauses covering rises in wages and materials as to make them approximate to that type of contract. Now that the first rush is passed and bills of ever-increasing amounts are presented by the manufacturer, the consumer is somewhat taken aback by the magnitude of the totals and figures out the enormous turnover and profit required merely to write off reasonable depreciation on such large sums of capital invested. Labour still clamours for greater and still greater increases in wages. Sectional strikes take place with growing frequency. The purchaser, with perhaps only his immediate and most vital requirements satisfied, cancels orders, suspends work, and is content perforce to await with patience the arrival of more stable conditions. This tendency is to-day strongly marked alike in the case of individuals and of companies and corporations. Many instances could be given. As yet such cancellations have not had the effect appreciably of increasing unemployment, although this must be the result.

Passing reference should be made to the latest award of the Industrial Court award No. 180 of March 10, 1920, in which a basis, apart from the cost of living, was taken into consideration, and we may quote: "The present position in the engineering industry is abnormal owing to the great demand for engineering products in the devastated areas of Europe and in the home and foreign markets generally, due to the necessary rehabilitation of the industrial world which has been deprived in large measure of engineering products during the greater part of the war period. This position is therefore one which the Court feel should be taken into account under the general wages agreement among the 'abnormal conditions . . . due to the war' in connection with the claim made by the unions for an advance on grounds other than the cost of living. In addition, the Court have given consideration to the wages movements in other industries in comparison with those which have taken place in the engineering and allied trades, and also to the desirability of securing and maintaining for a reasonable period a measure of stability in the engineering industry." Exception has been taken to these grounds upon which the Industrial Court largely based this award, and their powers to such a decision have been questioned.

The unfortunate statement regarding the temporary prosperity of industry, has increased unrest by stimulating cupidity to demand such rises in wages as to throttle expanding trade and to impede the gradual post-war crystallisation of industrial organisation, so greatly to be desired. In making these ever-increasing demands some of the workers and their officials realise full well that the effects cannot be other than detrimental in the not far distant future, but they are content to take the shortest view, "to make hay while the sun shines," and to push their demands to the utmost of their increased strength and prosperity, resulting largely from natural development and the busy times of war activities, so long as the chances of a successful issue seem reasonably sure. No follower of present events or student of industrial affairs can be other than perturbed at the trend of present affairs leading to the danger of a deadlock at an early date. In some instances production is being maintained, and even increased, but the majority of evidence will go to show that the opposite is the case. The shorter working week has not by any means, as yet, been an unqualified success. No fixed deductions can yet be drawn since the eighteen months of operation have been somewhat unsettled, the strikes for a shorter week than the 47-hour week conceded, the moulders' strike, and so forth, all preventing that straight run necessary rigidly to define the issue.

It would seem to be an extremely difficult matter to reconcile the various conflicting factors where the ever present question of payment by results is concerned. Reference to bad management and short-sighted employers in the past, failure to realise changing conditions and the urgent demands of the present age, the fear of creating a larger measure of unemployment, suspicion and ignorance, still hold considerable sway. On most of these subjects we have repeatedly written. Unfortunately the provision for unemployment is the most pressing, and we still seek a fair and reasonable settlement, which, it is hoped by virtue of the legislation shortly to be discussed, may be soon reached. To the influence of time and improving education must be

left the dissipation of most of the fogs of ignorance, mists of suspicion, and the fulfilment of the hope of a longer-sighted policy in directing industrial affairs. Apart, however, from this somewhat particular side of the general question, the whole situation at present is charged with grave portents for the immediate future. Reduced production, increasing wages, and diminishing demand are rapidly leading to a position when the scales of economic balance, still swinging steadily towards instability will inevitably be thrown back.

It is to be hoped that the position will rapidly improve; that events will not move so rapidly that they are incapable of being coped with as they arise. Time is so much the essence of all such matters, and is required for a full realisation of the changes in industrial matters which have succeeded one another so rapidly within the past few years as to amount almost to a revolution. We would urge upon all concerned with the question of wages and conditions of labour to give the closest heed to the inevitable consequences of thoughtlessly following the policy of "making hay whilst the sun shines." Parallels drawn from the careers of individuals cannot be applied to the masses. There are economic truths that cannot be disputed, and the slightest reflection should serve to show that there must be a balance between individual production and consumption, and that reconstruction demands a surplus of production. If a portion of the energies, scheming and waste being expended towards increasing wages were concentrated on securing a reduction in the cost of necessities of life, a much easier path would be found towards the desired goal.

EMPIRE TIMBER RESOURCES.

ENGINEERS and architects are not unnaturally averse from risking their reputations by specifying comparatively new and untried materials for the structures for which they are responsible, but circumstances frequently arise in which their natural inclinations are set aside by exceptional conditions. During the war, a shortage, or the complete absence, of a certain material often rendered the use of a substitute necessary, and considerable resource was displayed in applying such materials as were readily available to uses for which they had not been previously employed. In certain classes of timber used in aircraft construction the shortage was acutely felt, and, consequently, such varieties as were obtainable were employed for purposes for which they would certainly not have been specified in pre-war days. A similar state of affairs, of course, existed with other materials, but it is with timber that we are mainly concerned at the moment, since the shortage resulting from excessive war demands cannot be so readily made good as can a shortage of manufactured materials.

Although the forests of the British Empire must contain timber of every possible quality in quantities more than sufficient to supply our whole requirements, it is a fact that, for the five years preceding the war, about 90 per cent. of the timber imported into this country was of foreign growth. There can be little doubt that this unsatisfactory state of affairs was largely due to the fact that timber users were not sufficiently familiar with the properties of timbers grown within the Empire, and for this reason we welcome the efforts made by the Department of Overseas Trade to provide the necessary information. With this object in view they have organised the Empire Timber Exhibition, which was opened on Monday last at the Holland Park Skating Rink, London, W., and will remain open until the 17th inst. Here are shown an almost bewildering variety of timbers grown in this country and in the Overseas Dominions, and although the majority of the exhibits are of varieties possessing a beautiful appearance for decorative woodwork, cabinet-making, &c., a sufficient number of qualities suitable for structural work and other branches of engineering are shown to render a visit interesting and profitable to the engineer. Space will not permit us to deal exhaustively with all of them, but we wish to call attention to those varieties of timber grown in the Overseas Dominions which are suitable for engineering work and are also available for export to this country.

Perhaps the most important exhibit is that of the Indian Government, and this includes part of a composite corridor railway coach built in this country for the Great Eastern Railway Company. The coach is constructed entirely of Indian timbers, the exterior being of mahogany, the interior of the first-class compartment of silver greywood, and the interior of the third-class compartment of Andaman padauk. The latter material is similar in appearance to mahogany and can be used for many purposes for which the latter is employed; an aeroplane propeller of padauk, for instance, is exhibited. Another useful timber from the Andaman Islands is known as gurjun, and has a hard, firm, close texture which renders it a good substitute for teak. Indian tulip wood is suitable for the manufacture of drawing instruments, such as set squares, parallel rules, scales, &c., examples of which are shown, as also are curves of red pear, tee squares of thitaho wood, and straight-edges of thinwin; the latter wood is hard and compact and of a purplish black colour, and is well suited for turnery work such as tool handles.

Canadian timbers, of which 25 varieties are exhibited, are perhaps better known in this country than those of some other Dominions. Among them may be mentioned Western hemlock, against which some prejudice appears to exist on account of the poorer qualities of Eastern hemlock. It is, however, a useful timber for structural work, being both lighter and harder than Douglas fir, but not quite so stiff. Another Canadian timber known as Western cedar, has exceptional powers of resistance to rotting in a damp, humid atmosphere, and on this account has been satisfactorily employed for the roofs of weaving sheds, pulping houses, and other buildings in which excessive humidity prevails. A section of roofing suitable for such structures is shown composed of an internal layer of Western cedar separated from the outer boards by three thicknesses of tarred paper. Over the outer boards, which are of common pine, creosoted, is a covering of tarred felt and over this is a layer of pitch and gravel. Such roofs are, of course, somewhat expensive in first cost, but they have the advantage of great durability, and they can also be painted internally, which cannot be done if creosote is used as a preservative. Wooden continuous-stave pipes, which may be constructed of Douglas fir, have considerable advantages in the matter of transport in comparison with steel pipes, and are claimed to be just as durable; wooden spigot and socket type pipes, wound with stout wire, are also made for underground water supplies and examples of these are included in the exhibit of the Canadian Government.

The eucalyptus and turpentine timbers of New South Wales produce many hardwoods for bridge work, and street paving, and also for the construction of heavy transport vehicles. The varieties available for export include iron bark, which is excellent for piles and also for the spokes, hubs and felloes of wheels. Blackbutt and tallow wood are also useful for marine structures in that they resist the attacks of boring organisms such as the teredo. Blackbutt is also used for the scantlings of railway wagons and ironbark, above referred to, is employed for the arms of telegraph posts on account of its great strength and good weather-resisting properties. Examples of these, and other applications, are to be seen at the stand of the British Australian Timber Company, Limited, of 1, Oxford-court, London, E.C. 4. The karri and jarrah of Western Australia are, of course, well known in this country, where they are largely used for street paving.

A useful timber known as watercare, which comes from Trinidad, is exhibited at a stand in charge of the Cambridge School of Forestry. Watercare, or guatecare, is a hard, heavy wood, somewhat difficult to saw and plane, but it is very durable in all situations and is not attacked by insects. It has been largely employed locally for posts and also for piles driven into the ground. For piling it is said to be cheaper and to stand heavier driving than greenheart, and as plenty is available for export it is certainly worthy of the attention of engineers. It is obtainable in lengths up to 30 ft. and up to 16 in. square. Two varieties of mora, red and white, come from British Guiana and Trinidad. The white variety, however, has a bad reputation, having proved unsatisfactory in the dykes of Holland, although the red variety is said to be quite suitable for harbour works and marine structures generally; red mora is also useful for the construction of railway wagons. In general it may be said that the timbers of British Guiana are similar to those of Trinidad, but the supply available in the former country is practically unlimited. A variety of British Guiana timber, known as monkeypot wood, is claimed to be one of the best and strongest woods for wheel spokes, and also to be useful for piles. That country also produces a light timber called cirouballi, which resembles satin walnut, and is useful for building construction, although extreme durability cannot be claimed for it.

Another timber which appears likely to be useful for engineering work is a variety of ironwood which comes from British East Africa, and is known as musharage. It is hard, heavy and straight grained, is easily worked, but does not take nails well, and neither is it resistant to the attacks of insects. It can, however, be used for railway sleepers and is excellent for cart and wagon building. Mweri, another East African timber of somewhat similar characteristics, is also available for export in moderate quantities. For piling and marine structures, a timber known as ekki, grown in the swamp and rain forests of Nigeria and the Gold Coast, may be largely employed when it becomes better known. It is very heavy, hard and durable, has a high tensile strength (16,000 lb. per square inch, in the direction of the grain), has exceptionally good weather-resisting properties, and, for marine structures, has the advantage that it is not attacked by the teredo. Ekki has been largely used in Nigeria for the construction of wharves and jetties exposed to salt and brackish water, and as it is available for export, it might well be tried in other countries. It would also appear to be quite suitable for street paving blocks and has already been employed for mine supports and brake blocks.

It will, of course, be readily understood that it is impossible in an article such as the present to deal fully with all the timbers available for engineering work which are exhibited, any more than it is possible for the exhibition itself to deal exhaustively with the whole timber resources of the British Empire. Our object has been to call attention to timbers which are likely to be useful to engineers, but are at present practically unknown in this country. We have little doubt that several of the timbers above referred to would be largely employed if their properties were more widely appreciated and a regular and adequate supply were made available. The Department of Overseas Trade has done valuable work in both these matters, but more remains to be done, especially in the matter of supplies. It is obviously of little use to refer to the properties of timbers, however valuable those properties may be, if the timbers can only be obtained in small quantities locally. For that reason we have omitted all reference to timbers unavailable for export though many such are exhibited. Neither have we dealt with home-grown timbers and afforestation work in this country, not because these matters are unimportant, or uninteresting, but from considerations of space. Both are well represented at the exhibition.

ELECTRIC RAILWAY CONTACT SYSTEMS.

IT is remarkable how quickly things move in the domain of electrical engineering. Its "ancient history" is within the memory of many of us, and of its first protagonists no small number is still in very active being. Very many of the early, but still recent, controversies of electrical practice have solved themselves and the solutions have become the commonplaces of everyday work. All the old disputes about the respective merits of alternating and direct current, of the value or otherwise of three-wire distribution, of the best types of motor for specific work, of series or parallel arc lighting, and so on, are now for all practical purposes at an end. This rapid solution of so many of the problems of electrical work is undoubtedly to be attributed to the rapid advance of electrical practice, both in scope and application. Rival

theories have been put to the test on a large scale in the best of all schools, and the virtues and defects of all have been established in a manner beyond arguing.

What occurs to us as probably the latest example of an acute electrical controversy dying away in the light of very extensive practical experience is that which used to rage around the question of the relative merits of third-rail and overhead conductors for distributing the current to trains on electric railways. It is but very few years ago since this was a matter of very acute difference of opinion, and yet a stranger attending the meeting of the Institution of Electrical Engineers last week would probably have failed to perceive that there had ever been a serious difference of opinion about the matter. The occasion was the reading of a paper on "Electric Railway Contact Systems" by Sir Philip Dawson, and the tone and tenor of the discussion which followed the paper suggested very definitely that the old controversies are dead, or dying, and that we are on a fair way to the settlement by general agreement of the problems which the question involves. We do not suggest that all electrical engineers yet see alike on the matter, but we do suggest that there are clear signs of the approach of that consummation.

The question of third-rail *versus* overhead conductor for electric railways is apt to be confused with the parallel question of direct current *versus* alternating current. The confusion is natural, and no final decision in an individual case could well be come to except in terms of the type of current used. At the same time it may help to a clear understanding of the questions involved if the relative merits of the third-rail and trolley wire are considered for a moment as an independent engineering problem. In any electric railway in which current is continually collected by the train it is necessary to have some kind of bare conductor running parallel to the track. (We may leave surface contact systems out of our consideration.) Since it is fair to say that at any voltage this conductor is more or less dangerous it would at first sight appear desirable to fix it overhead and out of the way of the permanent way men. There are some obvious objections however. The first is the expense both of installation and maintenance, and the second is the possibility of a considerable part of the overhead structure being carried away in a train wreck.

We cannot quote any relative figures for the costs of overhead and third-rail construction, and naturally the actual cost in any individual case will depend on local conditions and the type of job aimed at. Nevertheless, in general terms the third-rail is clearly the cheaper form of conductor to adopt. This cheapness is offset to some extent by the fact that other road maintenance charges are increased by the presence of a third-rail on the ground, but we think this consideration will not alter the relative positions of the two forms of construction from the point of view of cost. The matter of the liability of serious damage of the overhead structure owing to a train wreck, or even a comparatively minor derailment, is one which as far as we know has not been brought prominently forward by actual accidents of the kind. The question, however, which was mentioned by Mr. H. E. O'Brien in his discussion following Sir Philip Dawson's paper, is not one which can be ignored. The danger is not so much that a bad wreck may bring down the overhead structure, since a bad wreck will in any case take a considerable time to clear up. The danger is that the derailment of, say, a few trucks may wreck a number of standards and turn an accident which could be cleared up in a few hours into one involving a partial, or complete, shutdown of the line for several days. No parallel amount of damage is likely, or even possible, with a third-rail system.

This consideration cannot be ignored, but it is hardly likely to be the determining factor in any decision affecting the adoption of either third-rail or overhead construction. Other matters will settle the question. Cost is an important one, and the extent of its bearing does not yet appear to be sufficiently appreciated in this country. This latter fact is, incidentally, well illustrated in connection with housing. It has apparently not yet dawned on our various housing authorities that as financial affairs now stand we simply cannot afford to build as we did in pre-war days. A cheaper type of house must be designed and built. It may not be so nice as the kind of house we are used to, but if we cannot afford anything else we shall be finally forced to it. No ultimate salvation can come from an endless borrowing and putting off the real paying to a later day. The same state of affairs arises in connection with railway electrification and, indeed, with most other things. If any particular type of electrification is effective for its purpose and is the cheapest possible it should be adopted even though other but more expensive systems should have points of superiority. What is now of greatest importance of all is that railways and other public services should pay their way.

It is unfortunate for our simplified argument that the issue between third-rail and overhead contact wire cannot be settled by a consideration of the qualifications of the two contact systems in themselves. So much is this the case that no purpose would be served by deducing anything from the simple considerations we have so far dealt with. They have, however, we trust, brought out in a useful way some of the elementary qualifications of both systems, which must be kept in mind in any consideration involving more complicated issues. Any actual decision for the use of either type of construction must depend on many factors, and of these one of the most important is the type of traffic to be handled, and it is this factor which appears to be leading to a common opinion in this old controversy. As traffic units have become heavier and the current to be collected consequently larger, there has been a tendency to raise voltages, in order to cut down conductor sizes and also keep the current collected within manageable proportions. This proceeding also, of course, increases the distances between sub-stations and cuts down their number. This tendency to increase voltage has been seen in connection both with third-rail and overhead conductor working, and third-rail pressures up to about 1,500 volts are now fairly common.

As third-rail voltages increase the rail itself becomes a more and more undesirable adjunct to the running track, and in complicated goods and marshalling yards becomes an impossibility. One result of this is that there are now existing examples of third-rail systems with overhead distribution for the yards. We do not know that there is any serious objection to this sort of mixed contact system, but it illustrates the tendency for the conductor to rise from the track level to some position overhead. And this leads to what appears to be the general agreement towards which this question is tending. The general increase in pressure and the general desire to increase pressure will, we imagine, lead to the overhead contact wire becoming increasingly the common construction of the future. We do not anticipate the disappearance of the third-rail or that no further third-rail systems will be installed, but it will probably be found that a general tendency towards overhead work will be shown. One may hope and anticipate that not a little of the electrification of the future will aim at dealing with a more miscellaneous and a heavier type of traffic than has yet been generally handled in this country. To avoid the collection of heavy currents and to facilitate long distance distribution one may expect a tendency towards the order of voltage which is associated with alternating current rather than direct-current systems. This will necessarily imply overhead collection. There is, of course, at the present time a technical commission inquiring into the future best system for railway electrification in this country, and it will be a matter of no surprise if it is found to recommend overhead construction for long-distance or main line work.

THE INSTITUTION OF NAVAL ARCHITECTS.

WHAT promises at the time of writing to be a very successful summer meeting of the Institution of Naval Architects opened at Liverpool on the morning of the 6th inst. We understand that a total of some 350 members of the Institution and their guests are taking part. A large number of ladies are attending. The proceedings of the first day began at 10 a.m., when a meeting was held in the Council Chamber of the Town Hall. A welcome was first extended by the Lord Mayor of Liverpool, who said that it was thirty-four years since the Institution of Naval Architects had held a meeting in Liverpool. The town was one which owed a very great deal to the profession of naval architecture, and he was glad they had again decided to hold a summer meeting in it. He trusted their proceedings would be both pleasurable and profitable. The president, the Earl of Durham, replied to the Lord Mayor, and referred to the rise of Liverpool and its present very prominent position in the world of the mercantile marine. Liverpool, although not an old town in the historic sense, had done much to make later history, and its merchant princes had worthily carried on the best traditions of the pioneers of the past.

THE FUNCTIONS OF THE MERCHANT SHIP.

The Lord Mayor then vacated the chair in favour of the president, and the meeting proceeded to the consideration of the two technical papers which were to be taken at the sitting. The first of these was one entitled "The Functions of the Merchant Ship," by Sir Norman Hill. It was read by the author. As we reprint this paper in full on page 59 of this issue we can proceed at once to a report of the discussion.

Sir John Biles was the first speaker. He said the paper was one he had long looked for at the Institution. He thought the question of the development of shipping could and should be brought into the area of scientific economics. The Institution had had papers before which fell within the same class, but Sir Norman Hill's paper brought forward a considered examination of economic possibility in a way that was new, and pointed to the directions in which future investigations should be made. At the end of the paper also there was a contribution to the polity of the matter in relation to labour. There was one point of view in the paper which was new to him. He referred to the two ways of looking at the economic value of a ship. There was the usual shipowner's way, which was from the point of view of the economic value of each cargo carried —that was the economic value from the point of view of the ship. The other view introduced by Sir Norman Hill was the economic value of the ship from the standpoint of the maximum number of cargoes she could deliver. The interesting question was raised of the real value to the community of the maximum delivery of cargoes *versus* the economic value to the shipowner of each cargo.

The economics of shipping generally had perhaps too much been dealt with in a general way. He had written articles himself, but we wanted something more than generalities. He had prepared some matter for the Dominions Royal Commission on the precise investigation of some of the economics of shipping, and a paper had been read before the Institution by Mr. Anderson, dealing with loading and discharging as it affected the size of ships. Precise investigations of this kind were of much value, but they involved great labour, and the question arose as to how research in the economics of shipping on a large scale was to be carried out. He thought it could only be done either by some department of State—by, say, the Ministry of Shipping or the Board of Trade—or by the endowment of research in some university. He would much like to see the establishment of a chair of the Economics of Shipping.

Sir Westcott S. Abell was the next speaker. He said he had great sympathy with the idea of endowed research as put forward by Sir John Biles. The paper of Sir Norman Hill was of value to him since it looked at the technical problems of shipping from a new angle. The reference to the development of coastal delivery struck him as important. There had been no development of coastal shipping equivalent to the development of overseas service, and yet such development should be more and more in the interests of the consumer in view of mounting railway costs. The working out of any scheme for the development of coastal traffic was, however, full of difficulty, and it would be interesting to know if Sir Norman had any proposals to make. The great difficulty arose in connection with the sorting

of a general cargo. He was quite prepared to admit that winches and derricks were probably not by any means the last word in the handling of general cargo, and one might for instance see some development of the moving stairway idea, but the whole matter was full of technical difficulty. There was an interesting question which arose incidentally. For reasons in no way connected with the handling of cargo, our experience in the war suggested that it was desirable to fit lots of bulkheads. This, however, naturally made the holds deeper in relation to their length, and it became an interesting question as to what should be the relation between the length of a hold and its depth from the point of view of the economic handling of cargo.

Mr. Alexander Richardson, M.P., said that one of the great points of value in Sir Norman Hill's paper certainly was that it increased the range of our vision. It was very desirable that naval architects should be brought into fuller and closer contact with shipowners and shipping problems. In connection with one of the points Sir Norman had mentioned—the small increase in average speed of shipping which had taken place over a number of years—he would point out that although the speed might not have changed, there had been a great increase in the efficiency of the engines which gave the speeds, owing to the developments which had been brought about by the work of marine engineers. These increased economies had had important effects on profits. The general question of the economic ship was, however, a very difficult one. A great improvement in the time of "turn-round" was desirable, and the shipowners' problem was to determine the best ship of a given size, having relation to the availability of cargo, on a given route. In the case of Cardiff, for instance, a ship could get a full cargo out, but not a full cargo in. The ship accordingly had to run some of her time in ballast. These conditions made for large ships and, in general, when trading always between two ports the large ship was probably the best.

When considering the question of the length of time a ship had to spend in port, it was necessary to remember that if one installed very complex cargo-handling appliances on the ship they would be very costly and heavy, and would have to be carried about everywhere. It was necessary, therefore, to consider to what extent the appliances should be on the ship and to what extent they should be at the ports. The determination of this question in any particular case depended to a large extent on questions of bulk cargoes, facilities of overside delivery, and so on. These examples merely illustrated the difficult nature of the whole problem, and as an introduction to that problem Sir Norman Hill's paper was certainly of great value and had given the members of the Institution much to think about. Mr. Richardson went on to say that he would be glad to think that the paper had sown a seed which would ultimately result in the establishment of a Chair of Shipping Economics in the University of Liverpool.

Mr. John Anderson was the last speaker in the discussion. He said that he did not know if Sir Norman Hill was referring to his paper of two years ago when he said "the time spent by the ship in port has been described as lost time." Sir Norman had criticised this idea, but surely it was correct. A ship was only performing the function for which she was built when she was carrying cargo from port to port, and a perfect ship would surely be one which on arriving in a port could instantly discharge and sail again. Dealing with more specific matters, he would point out that the normal cargo-handling equipment for a ship 400 ft. long would be 10 winches and 10 derricks. Naval architects, however, could provide twice this number of winches and derricks if the shipowner wanted them—but he didn't. The owner didn't want more appliances, simply because the cargo could not be taken away from the quay quickly enough to make them of value. The naval architect up to the present time had kept well up to the requirements of the shipowner. Cargo could be handled by existing appliances from a 400-ft. ship at the rate of 30 tons to 32 tons an hour, but owing to congestion on quays and other matters the present average rate of working was not more than 12 tons an hour. The greater part of the loss was due to arrangements made in the quay sheds. As an example, in Greenock 8,000 tons of sugar delivered from a ship had all to be weighed in the quay shed on three weighing machines, and the capacity of these machines determined the rate of unloading of the ship. The solution of a large part of the whole problem depended on shipowners giving much more attention to port facilities.

Sir Norman Hill, replying to the discussion, said that the point raised by Sir John Biles was a quite correct one. There was a difference between the economic value of a ship to the shipowner and to the cargo owner or consumer. The point raised by Mr. Richardson illustrated this. The obtaining of equal speed with modern ships as with old, but with the employment of less labour and coal, affected the shipowner, but did not affect the consumer. It was important, however, that the difference between the points of view of the shipowner and the consumer should not be magnified. The ultimate prosperity of shipping depended on the prosperity of the consumer. In reference to Sir John Biles's proposals for a more comprehensive investigation into shipping economics, he would issue a warning against depending on any department of State to do the work. When war was declared no department had any record of the volume of cargo brought to this country. If one wanted this work done properly he must do it for himself or, as suggested, get it taken up by some young and active university. In reference to Mr. John Anderson's remarks he would say that he did not specifically have his paper in mind when referring to the idea that time in port was lost time. The idea was a fairly common one. He agreed with Mr. Anderson's definition of the ideal ship.

A vote of thanks to Sir Norman put by the president concluded the consideration of this paper.

MERCHANT SHIP CONSTRUCTION AND WAR EXPERIENCE.

The meeting then passed to the second paper, which was entitled "Some Features in the Design and Construction of Mercantile Vessels considered in the Light of Recent War Experience." The paper was read in abstract by its author, Professor J. J. Welch. We reprint the paper on page 37 of this issue.

Sir Eustace d'Eyncourt opened the discussion by invitation from the president. He said he was ill-prepared for the duty, but was glad to have an opportunity of paying a tribute to Professor Welch's valuable work. Not only during but before the war Professor Welch had done important work in connection with bulkheads and the instances he had given confirmed the conclusions of that work. He was afraid that a large number of the losses which occurred could only be put down to neglect of the rules which had been drawn up. In too many cases loss was due to open side lights and watertight doors not closed when ships were passing through danger zones. He could not but think that many of the losses might have been avoided if all the rules had always been obeyed. On the other side of the picture one had, of course, a record of splendid heroism in the face of enormous risks and frequent disaster.

He had made an investigation in connection with the loss of life on foundered ships which was of some interest, and the figures he had obtained illustrated to what a very considerable extent this loss was cut down when it occurred in cases in which danger was anticipated and measures taken in advance to save life in case of disaster taking place. He had taken, more or less at haphazard, 40 cases of ships lost before the war and 40 cases of ships lost during the war by torpedoes, mines, &c., and the figures showed that the percentage war loss was only one-third of the percentage pre-war loss. This illustrated the value of being ready for an emergency. Turning to another matter he would refer to the fact that in the early part of the war he had made representations with the idea of rendering ships somewhat safer in danger zones and had wanted merchant ships to be fitted with some of the devices which were being adopted in the Navy. He had, however, always been met with the cry that the most important thing was to get the ships out and that devices which would seriously delay them could not be considered. It was difficult to say which was the correct policy. He had wanted fewer ships, but ships which would be more likely to float. The other policy was to get as many ships as possible, but it led to a sort of paving the Atlantic with mild steel and was a serious matter when material supplies were short. Various protective devices were, of course, adopted in merchant ships such as the fitting of only one mast and one funnel, and placing them close together so that the course of a ship could not be conveniently observed from the periscope of a submarine. The bridge-ends were rounded for the same purpose and, of course, dazzle painting was used. The records showed that for ships over 11 knots speed the percentage of loss was very much reduced as compared with those of lower speed.

Sir John Biles was the next speaker. He was pleased to hear the commendation of the work which had been done by members of the Institution in connection with the subdivision of ships. He would ask how many of the special recommendations which had been made with the idea of reducing the losses of ships in war were to be continued in peace. The various cases of actual disaster dealt with by Professor Welch were of much interest, and in connection with case 3, to which he thought most people could put a name, it had been interesting to note how closely it resembled the case of the loss of H.M.S. Victoria. In both ships the damage was forward and the subdivision was extensive. The boat mentioned in the paper was lost because doors were left open, and H.M.S. Victoria foundered because water entered by upper deck ports which had been left open. Lessons of this kind should be followed out to the bitter end and appropriate safety measures taken in fog and at other dangerous times.

The first time he crossed the Atlantic, and the boat entered a fog, he noted that the bridge telegraph was put at half-speed, but that there was no alteration in the rate of revolution of the engines. He also noted that all side lights were open. The last time he had crossed the Atlantic it had been on a boat of his own design, so that he particularly didn't want her to sink. Even after special orders by the officers, however, he had found two side lights open in the fireman's compartment, and if the boat had been in collision this would certainly have led to trouble. This whole question was a very important one, and made it necessary to consider if some form of automatic closing sidelight would not have to be adopted. The question of watertight doors being left open was equally important, and it might be necessary to do away with some of them. Two ships were built in the 'eighties on the "no-door" principle. They had two boiler-rooms and three engine rooms connected by a lift service. Owing to difficulties in the engine room which had nothing to do with the no-door principle, connecting openings were finally cut in the ships. They were, however, fitted with doors of the automatic closing type which had to be opened to get through and automatically closed themselves. It was important to know that it was both possible and practicable to have ships without watertight doors.

Mr. S. V. Goodall said that he had had considerable experience in connection with United States shipping during the war, and that experience in every way confirmed the recommendations which had been dealt with by Professor Welch in his paper. Decks and bulkheads which were labelled watertight should be kept watertight by the ship used.

Professor Welch, in reply, briefly thanked the various speakers for their remarks, and in answer to Sir John Biles stated that he did not know which of the various war measures for safety were being continued in use in peace. He thought present administrations were alive to the importance of the matter. A vote of thanks to Professor Welch then followed, and the morning meeting was concluded.

AFTERNOON VISITS.

Immediately after the morning meeting the members and guests proceeded to Messrs. Cammell Laird and Co.'s Birkenhead yard, where a lunch was provided by the firm. Mr. W. L. Hichens presided at the lunch and, in a speech of welcome, spoke of the paramount necessity of maintaining our mercantile marine and the folly or worse than

folly of those who in any way were acting so as to increase the cost of shipbuilding. This applied to masters and men alike and was suicidal.

The president replied for the Institution, and after a few further words of welcome from Sir George Carter the party adjourned for an inspection of the works. We need give no further account of this visit as we fully described the yard three weeks ago. From Messrs. Cammell Laird's the party proceeded by tender to the White Star liner Celtic, on which tea was served by the White Star Company. In the evening of this day a reception was held in the Town Hall by the Lord Mayor of Liverpool.

(To be continued.)

NOTES.

Automatic Wireless Telegraphy.

It is a disability of wireless telegraphy that it requires a skilled operator. The same thing certainly applies to ordinary telegraphy, and one of the superiorities of telephony lies in the fact that its instruments can be operated and messages sent by anyone. The wireless telephone, apart from other limitations, has hardly yet reached the stage of use by anyone, and various tunings and other adjustments are necessary with any installation. The wireless telephone may ultimately reach a stage in which it can be put in an aeroplane or on board a ship, left there with no further attention and be always ready for anyone to use. While, however, it is advancing to this stage considerable interest attaches to any simplification of wireless telegraphy. An instrument enabling wireless messages to be sent by anyone has recently been brought out by the Automatic Telegraph Company, 132, Charing Cross-road, W.C. 2. It is a transmitting instrument only, and is not available for the receipt of messages. It consists of a clockwork-operated drum carrying contacts which work over fixed fingers on the lines of a tramway controller. The clockwork is wound up for each signal transmitted by pulling down a handle attached to the instrument case. The handle on release returns to its first position under the action of a spring, while the wound spring at the same time rotates the drum. The result is that the speed of operation of the drum, and thus the speed of transmission of the message, is out of the control of the operator. The drum is only about an inch in diameter by a few inches long, but by the employment of an additional smaller selector drum it has been possible to get a total of 60 signals from the instrument. These may, of course, be coded in any way. In addition each instrument carries a small drum which transmits the call signal for the aeroplane or ship on which the instrument is fitted. The call signal precedes every message sent and the disc may easily be changed if necessary. An additional lever attachment also allows of an "S.O.S." signal being sent. The signals are controlled by the operator from a plug board on the front of the instrument, and any of the 60 signals may be sent at any time. The instrument would allow an aeroplane to indicate its position and future movements, or a ship, say, to fishing boats, to do the same thing or signal information for instance about its catch of fish. The appliance should be of value in cases in which the carrying of a wireless operator is not justified. It will be understood that the instrument as we have described it is a control apparatus only. It has to be used in connection with a valve or other form of wireless transmitter.

The Control of Water Power Resources.

The Water Power Resources Committee, who issued their first interim report last year, had, subsequent to their appointment, their terms of reference enlarged to include the consideration of the means necessary to ensure the proper use of available water supplies. It is obvious that power supply cannot be considered in this connection to the exclusion of other requirements. In many cases available supplies can quite possibly be put to more important uses than the development of power. There is, first of all, the need of water supply for health, sanitation and domestic services. This should stand before other claims, and, with the improved conditions of living and the increasing use of water in our houses, the authorities will need to assure themselves of supplies likely to meet all reasonable future demands. Then there is the water required for industrial purposes, not only in steam plants, but in the dyeing, brewing, and other industries, many of which cannot exist without an abundant supply of good water. The Committee, in a second interim report just issued, quite properly place first these two claims for available water, and, following them, they put the water requirements of canals and waterways and the power schemes. Most will be inclined to agree with this order of relative importance, especially in a country such as this, where alternative means of transport and of power generation exist. In their present report the Committee have formulated their views regarding the future safeguarding of these various interests, so that when the demand may arise it will not be found that water required for one of the more vital purposes is no longer available, as the result of ill-considered concessions made in previous years. To ensure the careful expert consideration, therefore, of all future schemes, in order that such vital needs may not be jeopardised, the Committee suggest the appointment of a permanent commission of not more than three technical experts, and a chairman, which should act as a central authority on all water questions. The proposed Commission would compile complete records of water resources, would consider future requirements, readjust existing allocations of supply, and assist Government departments and Parliamentary Committees in dealing with these questions. The Commission would be, it is suggested, assisted by an Inter-Departmental Water Committee, in order to co-ordinate their requirements, and bring conflicting interests into harmony. It is proposed that all schemes relating to water supplies should be considered by this Commission, and that in the event of its refusing consent, the promoters should still have power to bring in a Private Bill, the Commission reporting to Parliament during the committee stage. Departing somewhat from the avowed subject of their report, the Water Power Resources Committee further recommend that the State, through the Department of the Board of Trade, or the Electricity Commissioners, should be able to assist development by advancing funds on approved schemes during their early years. It will be admitted that the water resources of the country should be dealt with in a comprehensive way, and not merely from one restricted point of view only, and something will certainly be gained if the work of the Committee results in an advance in this direction.

The Institution of Civil Engineers.

The first *conversazione* to be held by the Institution of Civil Engineers since 1914 took place on Tuesday evening last when the capacity of the large building in Great George-street was taxed to the utmost by the crowds of members and friends who were present. The guests were received by the president, Sir John P. Griffith, and Miss Griffith, and the Council of the Institution. The entertainment provided consisted of excellent music in the rooms upstairs, while on the ground floor rooms an interesting collection of engineering exhibits had been arranged. The museum illustrating the deterioration of structures exposed to sea action was also open and attracted considerable attention. This museum may be regarded as the nucleus of what promises to be in the future a collection of quite exceptional interest and importance. The engineering and scientific apparatus were arranged in the three rooms known as the South Reading Room, the Council Room, and the Committee Room. The latter was occupied almost wholly by a collection of some dozen exhibits arranged by Sir J. E. Petavel, K.B.E., of the National Physical Laboratory. These included various types of measuring machines, an end-measuring comparator, micrometers, optical projection apparatus, gauges of various kinds and so on. Most of these we have dealt with on previous occasions when giving accounts of the Teddington institution and its work, and we need not enlarge upon them now. The great feature of the exhibition as a whole was the large amount of apparatus devoted to fine measuring. This, of course, is somewhat natural after the last few years, in which the widespread adoption of work of real accuracy became so essential. The National Physical Laboratory's collection was typical of the rest in this way. The Royal Ordnance Factories, Woolwich, arranged an interesting collection of gauges, measuring apparatus, &c., including a set of nine gauges and checks for the regulation 0·303 S.A. cartridge. Sir Horace Darwin, K.B.E., also showed instruments for fine measurements, including extensometers and workshop microscopes. In this collection was shown a self-testing square, consisting of two parallel faces joined by a third. The two parallel faces are provided with spirit levels, and are faced up to these, while the third is faced up subsequently to an angle plate till the bubble position is correct for both parallel sides. By permission of Captain H. Riall Sankey, C.B., C.B.E., Messrs. Marconi's Wireless Telegraph Company exhibited several pieces of historical apparatus, as well as a marine type direction finder, and a receiving set. An automatic calling-up device was also shown, for sounding a gong on ships carrying only one operator. Mr. J. S. Wilson and Professor W. E. Dalby exhibited two instruments for ranging for anti-aircraft guns. These we propose to refer to later at somewhat greater length. Professor Dalby further showed photographic records of tests of materials, and instruments with which they were made. By the Loughborough Technical College a set of gauges was shown, and a jet-measuring apparatus, consisting of a frame of eight small pillars fitted with two sets of radial pointers, each pointer being arranged with micrometer measuring scales. An ingenious device, which was brought out before the war, was shown by Sir John Dewrance, K.B.E., and consisted of a pump for viscous fluids. This pump consists of a spindle on which are cut two spirals, one right-hand and the other left-hand. The discharge is at a port in the body opposite the point where these spirals meet. Pressures of 1,000 lb. per square inch can be attained. The quantities delivered are, of course, comparatively small, but would be suitable for forced lubrication, &c., under certain conditions. The pressure attained depends on the depth of the grooves. The movement may be as low as 45 r.p.m., or ratchet motion may be adopted with satisfactory results. We have not been able to refer to all the exhibits, neither would it be necessary to do so as very many of them, although of great interest to the guests on Tuesday, are already familiar to readers through our columns. In concluding this notice we may mention that on Tuesday last the Great Hall of this Institution was for the first time seen in its completed state. During the period of the War the Hall was occupied by the Government and the completion of its decoration was thus delayed. This work, including a painted ceiling—due to the generosity of the President—has now been carried out in accordance with the original designs and with an exceedingly satisfactory result.

"Meldrum's Magazine."—The magazine for May issued by Messrs. Meldrum's Limited, Timperley, near Manchester, gives illustrated information on their furnaces and stokers, and announces that the next issue will deal with the use and combustion of refuse and inferior fuels.

Gas Reactions and Ionisations.—When it was observed that gas ionisation seemed to accompany various gas reactions, it was supposed that the ionisation might be essential to chemical reactions between gases. But exact researches failed to yield any conclusive evidence of any ionisation in cases where liquids, which might favour ionisation of gases bubbled through them, were absent. Hence two alternative views have been proposed: The gas reaction requires an actual splitting-off of electrons, leading to ionisation; or the gas reaction requires merely a loosening of the electrons, without any destruction of the atomic or molecular structure, and without ionisation. The latter view has mainly been developed by Kossel. A few years ago R. Pinkus, studying at Geneva the interaction between nitric oxide NO and chlorine Cl, believed to have some definite evidence of ionisation on mixing the two gases when chlorine was in excess; the nitrosyl-chloride NOCl formed boils at − 5 deg. C., and no liquid would therefore be present in the glass vessel used at temperatures above freezing-point. Repeating these experiments of Pinkus, at Heidelberg, Max Trautz and F. A. Henglein (*Zeitschrift für Anorganische Chemie*, April 20, 1920) observed no trace of ionisation, however, when every precaution was taken. Thus the actual liberation of electrons would not appear to be essential for gas reactions.

THE NATIONAL PHYSICAL LABORATORY.

(*Concluded from page 20.*)

Heat Department Expansion of Metals.—The two simple methods of determining the expansion of metals, worked out by Dr. Ezer Griffiths and demonstrated by him and Mr. F. H. Schofield, will be of interest to the engineer who would be more anxious himself to study the properties of his materials if the methods available were more suitable. In the first of these methods the rod under test, say 1 cm. in diameter and 40 cm. long, is placed in a silica tube closed below, to the open end of which a dial test indicator is attached. The tube is considerably longer than the rod, so that a solid distance rod of silica can be inserted between the specimen and the indicator, and that the specimen itself, in the lower end of the tube, may be well within the furnace or constant-temperature bath, from which the other parts project. The expansion is directly read off on the dial, and there is no danger of forcing out the bottom of the test tube when screwing down the micrometer. Measurements are taken within 1/2000 of an inch; the expansion thus deduced is, of course, relative to the known expansion of silica.

The second more exact method, originally devised for a special purpose for samples about 1 in. in diameter, makes use of a comparator bench and it effects an absolute measurement without exposing the comparison standard to the wide range of temperature. The comparator illustrated in Fig. 5 was built up of apparatus which happened to be available, but has proved capable of a high degree of accuracy, at present at temperatures up to 450 deg. C. The bar is placed in a furnace consisting of heavy iron tubing wound with nichrome wire. Two holes will be seen near the ends of the tube; these holes are opposite grooves marking the fiducial length for the miscroscopes which are sighted upon the holes. The bright grooves are machined into the bar, and into each groove drops a pair of clamps holding a small right-angled prism. Diagram Fig. 6 explains this novel device of Dr. Griffiths. The prism rests on a three-point contact with the bar, the third point of support being on the axis of the bar. A fine line engraved on the prism face is illuminated by the light of a glow lamp mounted near the end of the furnace, and the image of this line (reflected by the prism) is observed in the miscroscope; in the final construction the prism face is to be platinised.

The observation holes mentioned above are exactly opposite the prisms, and the miscroscopes are traversed parallel to the bar by two micrometer screws, and readings can be taken to 1/400 mm. The comparator bed is a piece of an ordinary steel girder, which will itself change its length; this change is checked against a standard scale by means of a rack (the carrier of an electric drill). The bar can be replaced by this engraved standard scale, which is shown in position in our Fig. 5. Under ordinary conditions the effect of changes in the room temperature is negligible in comparison with the changes in the length of the heated specimen. Temperatures are determined with the aid of thermocouples pegged directly to the bar at a series of distance points.

Specific Heat of Granulated Materials. Cold Storage.—The question of the specific heat of light or granular materials, such as cork, sawdust, charcoal, also slag wool, &c., used for heat insulation arose in connection with the researches of the Heat Department for the Food Investigation Board and on cold storage. The method of mixture cannot satisfactorily be applied in these cases, this being particularly the case when the materials do not bear heating to anything like a high temperature, while experimenting with compressed blocks tells us little as to the properties of the loose material.

In the clever apparatus employed — unique, we believe—the loose material is heated through small ranges of temperatures by a measured amount of electric energy, and the heat capacity of the container is kept low not to become comparable to that of the material. The calorimeter adopted is a cylinder of thin sheet aluminium, provided on its inside with helical fins; the cylinder turns on its longitudinal axis about twice a second. The axis is surrounded by a skeleton framing on which bare resistance wire is wound in an open spiral.

The cylinder is charged with less than half its capacity of the loose material. As the cylinder rotates the grains drop through the stationary spiral; the fins carry the grains along longitudinally and, to make the mixing thorough, the cylinder is not only rotated about its horizontal axis, but swung round also in other directions. Since the heat capacity of the cylinder is kept low, whilst the surface is large, there would be considerable loss by radiation from the cylinder. To avoid this the whole cylinder is encased in a larger copper drum which is itself heated by another coil, at the same rate as the calorimeter. After making sure that the cylinder, material and drum are at the same temperature, the current is sent for about twenty minutes into both the coils, the drum and the cylinder wall temperatures being measured alternately. The current is varied until absolute equality is reached, and the current then switched off. The material is thus heated from one stationary temperature to another stationary temperature. The materials to be tested are first finely subdivided, care being taken not to char materials like cork when grinding them. Moisture tests are also made.

Humidity in Cold Stores.—In order to have an atmosphere of constant humidity the special cold storage room fitted up in the basement of Bushy House is supplied with air which is passed over the outside of a large coil of piping, through which cold brine is circulated; the coil is placed near the wall behind a partition. A fan draws the air to be dried over a tray charged with calcium chloride, and sends it through a duct back to the brine coil; the air humidity is thus reduced to 55 per cent. Such air is, however, much drier than that of commercial cold stores; air containing a considerable amount of water vapour may yet appear dry to us. To determine the humidity in the air near freezing point the ordinary wet and dry bulb thermometer is not suitable; but Assmann's aspiration hygrometer, through which the air is drawn by a fan, will answer under conditions now being investigated. Another method under examination is based upon the fact that the refractive index of glycerin changes with its moisture content. By evaporation or condensation a solution of glycerin in water gets into equilibrium with the vapour pressure of the water in the atmosphere. By working with a very thin film of glycerin it is hence possible to follow closely the hygrometric state of the atmosphere. A film of the glycerin solution is obtained by soaking a sheet of cigarette paper in the solution and laying the paper on the face of the prism of an Abbe refractometer. A third method tested is based upon the heat evolution observed in dry cotton when exposed to moisture; the change is observed by the change in electric resistance.

The duplex reversal key of Dr. Edgar A. Griffiths was noticed in our comments on the recent Royal Society Soirée;* we should add that the key is also made in a single form.

The Thermometry Section and the Radium and X-ray Section had not made arrangements for special demonstrations on the occasion of the annual inspection.

Electricity. Fundamental Units. General Measurements. Thermoionic Valves.—In most of the apparatus demonstrated by Messrs. F. E. Smith, F.R.S., D. W. Dye, S. Butterworth, R. L. Smith-Rose and L. Hartshorn, thermoionic valves were either themselves being measured, or they were utilised for other determinations. The determination of the static characteristic of a triode concerns the relation between the plate and grid potentials and currents, and the curves obtained generally rise rapidly to a flat maximum. The Teddington methods are used elsewhere, but special precautions are taken, for instance, to ensure that the filament temperature is constant; the filament is put in one arm of a Kelvin bridge. The derived characteristic, obtained when grid and plate volts vary together, is much more important than the static characteristic, because it concerns the valve when oscillating; the curve then found does not rise to so high a maximum and drops off again with rising grid potential to a lower level.

Mr. F. E. Smith's method of measuring the efficiency of a transmitting valve is exceedingly interesting. In valves worked at high anode (plate) potentials, the plate (the cylinder surrounding filament and grid) may become red hot by being bombarded by electrons; this heat is wasted energy, and the method is based upon measuring that energy. An optical pyrometer is sighted on the anode; the observation is taken through the bulb glass, which does not matter, since the determinations are relative. The potential and current between plate and grid, and thus the input energy, are measured, and the energy is plotted against the temperature. The calculation is made in the first instance when the valve is not oscillating (the condenser being cut out); all the energy is then turned into heat and the anode gets red hot. When the oscillations are started, the anode is less heated and looks dull; a new curve is plotted. The comparison of the two curves gives the heat wasted; the remainder represents the oscillating current and from that the efficiency is deduced; it ranges from 30 per cent. to 60 per cent. By means of a Duddell hot-wire current meter the current in the output circuit is further measured; in this way the effective resistance in the circuit of a coil at high radio-frequency can be determined—a determination which it is difficult to make in other ways.

In measuring the amplifying power of valves at audible frequency, Mr. F. E. Smith makes use of a Campbell inductometer, and an air-core transformer. The use of a few letters will facilitate the explanation. The primary of this transformer is a ring coil P within which two secondary coils S_1 and S_2, rigidly connected to be at right angles to one another, can be turned about their common vertical axis; as this secondary cross S_1, S_2, is turned, the mutual inductance between the primary and either secondary changes, and this inductance is first determined for various angular positions of the secondary. In making amplification measurements the intensity of the note produced in a valve V_1 is taken as reference standard; let V_2 be the valve (or group of valves) to be measured. The primary coil P is supplied with alternating currents of known frequency; by means of a multiple switch either S_1 or S_2 is rapidly connected with the grid or the filament circuit of V_1 and then of V_2; the switch alters at the same time the telephone connections with the anode of V_1 or V_2; when the telephonic intensities are the same, the ratio of the respective inductances between P and either S_2 or S_1 is a measure of the amplification due to V_2. This method has to be modified for valves of high, inaudible frequency..

We should also notice the collection of valves of different types, exhibited with the other apparatus in the Radio Hut. There were many interesting experimental valves, including some double valves in the same tube (to secure identical external conditions; they are now supplied by one firm), some valves from German submarines, and a 0·5-kw. valve from the Osram Company.

The multi-vibrator of H. Abraham and E. Bloch is utilised by Mr. Dye for the absolute measurements of radio frequencies. In this multi-vibrator two valves are peculiarly connected, the first grid through a condenser to the second anode and back through another condenser, both the anodes being also joined through resistance to a common high-tension battery. The one valve then acts as a trigger for the other and resets itself. The common circuit gives rise to oscillations, the fundamental of which depends upon the capacity of the grid circuit; the oscillations are however very "peaky," and superposed upon the fundamental are an almost infinite series of harmonics, the higher being closely crowded. Starting then from a musical note, say, of a frequency 1,000, the vibrator is tuned to that frequency; by the heterodyne method (of beats) any harmonic, say the hundredth is picked out and reinforced, and a measure is thus obtained for the highest frequencies. The circuit can thus serve for calibrating wave-meters.

In measuring the constancy of frequency of oscillating valves by the inductance-capacity bridge of A. Campbell (late of the Laboratory) a mutual

* ENGINEERING, June 25, page 864.

inductance and a capacity are so combined as to give balance for a particular frequency; very small changes in frequency, of the order of 1 in 1,000,000, can thus be detected, though not measured, with the aid of variable air condensers; most valves are now extraordinarily constant. The measurement of the effective small inductance of four terminal resistance standards is also due to A. Campbell, but it does not require a valve. When there are only two terminals, the problem can be solved by the aid of the Heaviside bridge. This bridge is not directly applicable, however, to four-terminal resistances in which the potential terminals are distinct from the other two. In these cases the primary circuit is not only directly linked with the galvanometer, but also indirectly by an intermediate closed circuit; the linking mutual inductance must be variable, but need not be known.

Mr. Dye's new method of measuring the effective resistance of self-inductances makes use of a Wheatstone bridge and condenser and relies on a valve for keeping the frequency constant. Measurements of high inductances from 0·1 henry up to 1 henry are a very difficult matter, and the determination

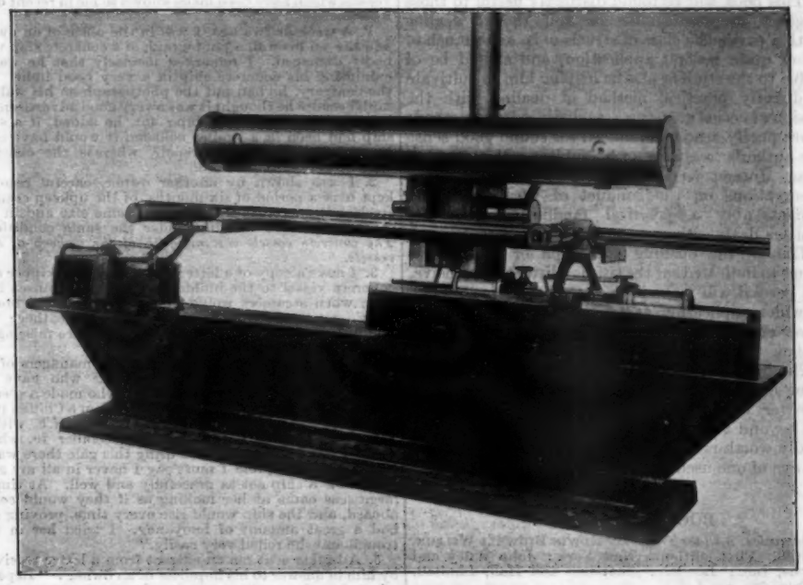


FIG. 5.

would not be possible without a valve. This valve, acting as source of alternating current, is placed at some distance from the bridge; the oscillations are picked up by a screen-transformer (*i.e.*, a transformer between the primary and secondary of which an earthed screen is inserted to guard off electrostatic effects and earth currents), the secondary of which is joined to the bridge. The bridge is precisely balanced for any frequency with the aid of a small variable inductometer (up to 0.01 microhenry).

Electrotechnics. Alternating Currents. Moulded Insulators.—There is not much to be said about the instructive chief demonstrations by Dr. E. H. Rayner and Mr. R. Spilsbury, the calibration of a voltmeter, up to pressures of 60,000 volts, and the determination of the errors in ratio and phase angle of instrument transformers. In the Kelvin voltmeter of the Laboratory, which reads up to 100,000 volts, the parts are all mounted on a marble slab, about 3 ft. diameter, within a sheet metal case. On the afternoon of the inspection the calibration of a new voltmeter was in progress—in the open air, not to have any accidents, the weather being favourable—the indications being checked against those of the Laboratory high-tension instruments. The determination of the errors of instrument transformers is a matter of very considerable commercial importance, since these instruments are wanted in the energy measurements of large-capacity plants. Moulded insulators, supplied in the shape of bars and cylinders by various firms, are being tested for electric strength and mechanical stiffness at different temperatures on behalf of the British Engineering Standards Association with a view to the drawing up of specifications.

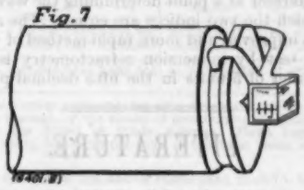
Photometry, Miners' and Ship's Lamps.—In the photometry department Dr. Rayner, Mr. J. W. T. Walsh and Mr. Buckley explained the determination of the illumination given out by miners' safety lamps (oil and electric) in various directions, a research conducted for the Home Office. About 50 lamps are being tested; the Laboratory is not asked to improve the candle power. In the experiments on the form of lenses for navigation lamps and on the tint and density of the glasses, use is made of a tilting wooden frame for supporting the lamp at different angles, up to 12·5 deg. above and below the horizontal; the brightness is determined at certain distances in accordance with the Board of Trade rules. The construction of electric lamp standards was also shown. In the new lamps the threads of the filaments are all stretched in one plane in the axis of the lamp, and the caps are rod-shaped and so constructed that, when the lamp is put in the socket on the photometer bench, the filament plane is at once in the correct position.

Direct Current. Selenium Current Regulator. Manganin.—Mr. S. W. Melsom and Mr. H. C. Booth showed a great deal less than they might have shown. The selenium-cell current regulator, was the only instrument exhibited which is connected with Mr. Melsom and Miss Cookburn's cable research, on which, we understand, a report has been presented. The current from the direct current generator goes through a 200 ampere shunt, and is balanced against resistance in a potentiometer through a galvanometer. The light from the mirror of this galvanometer falls on either of two selenium cells (about 1 in. square) in front of the galvanometer when the current rises or falls through a certain range; as long as the current is steady the light spot does not affect either cell. The cell, together with an electromagnet in its circuit, acts as a relay, controlling the resistance of the generator; the current is thus regulated within ¼ per cent. The selenium cells are sensitive, but require occasional checking.

That manganin is made in the Metallurgical Department of the Laboratory and rolled down there to rods and sheets has already been mentioned. The rods have hitherto been sent to a firm of wire-drawers, being returned to the Laboratory for electric testing, and then sent back for further treatment. It is well known that the drawing and annealing of this brittle alloy is very troublesome, and that apparently good wire may not always prove electrically uniform and constant. Some of the wires, in fact, came back in pieces. Recently, however, a 1 mm wire has been obtained which is even superior to the best German pre-war manganin; the curves exhibited proved that between 15 and 34 deg. C. the resistance of this wire does not vary by more than two parts in 1,000,000, the resistance first rising and then falling with rising temperature; beyond 34 deg. the fall is more rapid. Wire has been prepared of 0·0014 in. diameter also, and in addition manganin tape, 30 mm. wide, less than 1 mm. thick. Particulars as to the drawing and annealing are not available, but it is clear that the whole operation should be under one direct control, and that the supply of a good manganin, for which there is a wide demand, could best be secured by providing a wire-drawing plant in the Laboratory.

We may notice one other private research, on the contact resistance of busbars of aluminium and also copper. The questions of suitable overlap, of cleaning or greasing (with vaseline), the contact surfaces, pressing them together by hydraulic pressure, bolting, &c., are of greater importance than might be thought. A report on the results obtained is to be published.

Fig. 7



Optics. Optical-Lever Comparator.—We can mention here only two of the new methods of working demonstrated during the inspection, referring to previous reports as to the other demonstrations arranged by Mr. T. Smith. Mr. J. Guild explained his optical-lever comparator method for measuring the expansion of materials available only in short lengths such as a piece of glass. The specimen is mounted vertically on the upper flat surface of a quartz lens; parallel to it is mounted a platinum rod which serves as standard. On the top of the two specimens rests a disc of glass or quartz. When the specimen under measurement and the platinum rod are heated to the same temperature, the one will expand more than the other, and the disc will tilt; the tilt is a measure of the differential expansion. The parts mentioned are horizontally mounted on the top of a vertical silica tube, over which a tubular electric furnace is lowered, so that the specimen and the platinum rod are in the hottest zone, at temperatures up to 600 deg. C. By the side of the foot of the tube is a pointolite lamp, the beam of which passes through a lens on to a prism, the far side of which is blackened with platinum, leaving a few lines clear. The rays pass on to an inclined mirror which sends them up the silica tube. Part of the light comes back from the quartz lens; part passes through the quartz and is reflected from the tilted disc above it. The two images of the lens will not coincide; they are examined in an eye-piece, and their distances are measrued. This ingenious method does not rely on interference fringes, which is an advantage.

Immersion Refractometry.—The other novelty we have referred to is Dr. J. S. Anderson's method of determining the refractive index of a lens or of a fragment by immersing it in a liquid having the same refractive index for a given wave-length λ as the specimen. The point in this method is, of course, to find a liquid of the same refractive index as the specimen to be investigated, and for this purpose the strength of the liquid is generally adjusted by a delicate and laborious process. Dr. Anderson substitutes variation of the λ for variation of the strength of the liquid. Supposing we wish to find the index of a lens for a λ corresponding to the

C line of hydrogen. The liquid is roughly adjusted so that balance is obtained for a wave-length λ_1 in the neighbourhood of C; this λ_1 is determined—by a method presently to be explained—and the index for the C line or the corresponding angle reading on the refractometer is then quickly measured. The strength of the liquid is now slightly altered, and a new λ_2 of equal indices is determined. This is repeated for points on both sides of the C line; the indices or angle readings are plotted, and a curve is drawn through the points, from which the exact index for the C line is deduced. In Dr. Anderson's determination of the λ, for which the indices of the specimen and the liquid are equal, the image of a fine horizontal wire illuminated by a pointolite lamp is formed across the slit of a spectrometer; the lamp beam is sent through the cell containing the immersion liquid. The spectrum appears horizontally traversed by a fine dark line, corresponding to the point of the slit where the image of the wire falls on it. When the specimen is immersed in the cell in such a way that it intercepts part of the beam, the edge of the specimen being horizontal, another image of the wire, a second line will be seen in the spectrum, and the two lines will intersect at a point determining the wave-length for which the two indices are equal. The accuracy of this improved and more rapid method of carrying out a test by immersion refractometry is of the high order of 5 units in the fifth decimal place.

LITERATURE.

Structural Steelwork, relating principally to the Construction of Steel-Framed Buildings. By ERNEST G. BECK, Wh.Ex., Assoc.M.Inst.C.E. London: Longmans, Green and Co. [Price 21*s.* net.]

THE title of this book might still further be limited to indicate the treatment of structures of small height, the major part being as a fact concerned with the design of steel-framed sheds. The title is indeed the least satisfactory feature of a very excellent piece of work. The book opens with a chapter of moderate length dealing, in a useful way, with various practical matters—permissible stresses, factors of safety, punching, drilling, riveting, estimation of weights, &c.—passing from these matters to the theoretical consideration of elastic lines and deflections, showing the derivation of formulæ in common use, and examining some cases not usually given. The author makes a commendable attempt to give a clear concept of the moment of inertia and its allied values. The treatment will appeal to some, but perhaps not to all. It is somewhat unfortunate that these terms, borrowed from dynamics, were ever used in connection with questions of stress, though it may now be too late usefully to change them.

Stanchions are treated at considerable length, beginning with the simplest case of those axially loaded, proceeding to stanchions braced in groups, and stanchions laterally and excentrically loaded, finishing this section of the work—some 140 pages—with the practical design of stanchions. Beams and girders which in most works on structural steelwork are treated somewhat fully, are by Mr. Beck accorded a relatively small space, but this may be simply because the author recognises, what will be conceded by most designers, that difficulties of design are less likely to prove troublesome with such members than with those parts to which he gives more liberal attention. That the author concentrates on difficulties becomes evident on going through the chapters on roof trusses, and roof trusses with knee braces, and knee ties, with the further case of multiple bay knee braces, together with such complications as are introduced by columns of differing height and differing moments of inertia. The treatment of stanchions and knee-braced roofing is indeed very thorough, and gives this book a distinctive character which might perhaps with advantage have been indicated in the title.

Methods of calculation are partly analytical and partly graphical, whichever, in fact, seems to be most convenient. The explanatory text is clear and convincing. Mr. Beck, unlike some writers who rely much upon the mathematical expression of a truth, does not despise mere words. The majority of readers will be appreciative of the reasoned explanations which he gives for points of design, some of which cannot be otherwise expressed—the designing engineer has indeed to do many things in the course of his work which though quite wisely done may not be mathematically displayed; instances of this are to be found in Mr. Beck's treatment of his subject, together with considerable elaboration of methods of calculation applied to a number of cases not usually treated in text books. The views expressed respecting the effective length of columns and fixity of ends, are well worth study—these are matters which in a great number of cases cannot be rigidly determined, particularly is this the case with respect to fixity of bases. It is perhaps but little realised by many how far from true fixity may be the foot of a heavy stanchion bedded upon a concrete base of ordinary dimensions resting upon ordinary material. So far from being fixed, such a stanchion foot may more nearly approximate to the hinged condition, with the hinge at the under side of the concrete where it rests upon the ground. The authors remarks upon these and on other kindred matters should prove helpful.

This book will be found distinctly useful to those engaged in practical design, and though dealing with a particular class of structure is, as to much of it, of quite general application, and should be of value to the student also as helping him to cultivate a directly practical method of dealing with the design of actual structures, as distinct from methods more purely academic, indeed for sound good sense the author's treatment of his subject will be hard to beat. Interspersed throughout the book are many observations on the conduct of work indicating unmistakably a practical familiarity with the matters dealt with.

Though the opening paragraph of this review seems to indicate that the title is a little too inclusive, yet perusal will make it clear that there is so much of wider application as to make it of great use to those engaged in any branch of structural steel design.

The book is well illustrated with clear diagrams. Some details of roofing in the last chapter might, however, be advantageously revised with respect to lap beyond the end rivets of bars, a small matter hardly worth mentioning, though it at once catches the eye of one used to this class of work.

BOOKS RECEIVED.

Aeronautics, A Class Text. By EDWIN BIDWELL WILSON, Ph.D. First edition. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 22*s.* net.]

Oil-Finding: An Introduction to the Geological Study of Petroleum. By E. H. CUNNINGHAM CRAIG, B.A., F.R.S.E., F.G.S. Second edition. London: Edward Arnold. [Price 16*s.* net.]

A Primer of Trigonometry for Engineers with Numerous Worked Practical Examples. By W. J. DUNKLEY, B.Sc. London: Sir Isaac Pitman and Sons, Limited. [Price 5*s.* net.]

Lectures on Industrial Administration, Delivered at Cambridge, July, 1919. Edited by B. MUSCIO, M.A. London: Sir Isaac Pitman and Sons, Limited. [Price 6*s.* net.]

Employment Management; Selected Articles. Compiled and edited by DANIEL BLOOMFIELD. London: Sir Isaac Pitman and Sons, Limited. [Price 8*s.* 6*d.* net.]

The Field Manual; A Practical Treatise of Surveying Methods and Operations. By ARTHUR LOVAT HIGGINS, B.Sc., A.R.C.S., A.M.Inst.C.E. London: Sir Isaac Pitman and Sons, Limited. [Price 21*s.* net.]

Pumping Machinery: A Treatise on the History, Design, Construction and Operation of Various Forms of Pumps. By ARTHUR M. GREENE, Junr. Second edition, revised. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 23*s.* net.]

Field Engineering. A Handbook of the Theory and Practice of Railway Surveying, Location and Construction. By WILLIAM H. SEARLES, C.E., and HOWARD CHAPIN IVES, C.E. Eighteenth edition, revised and enlarged. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 21*s.* net.]

COAL CONSUMPTION IN UNITED STATES CENTRAL STATIONS.—Figures based on reports obtained from over 3,000 central stations give an average of 3 lb. of coal per kilowatt-hour, says *Power*, New York. The most economical plants are operating on about 1¼ lb. There is evidently an opportunity for improvement in the operation of the average central station as well as the isolated plant.

"THE DETERMINATION OF THE LOADS ON CRANE WHEELS."

TO THE EDITOR OF ENGINEERING.

SIR,—I find it difficult to follow Mr. Padfield's criticism on account of the seeming inconsistency in his arguments.

In his letter of June 19, he questions my methods on the ground that the centres of gravity of the resulting wheel loads on each rail do not lie on a line *perpendicular* to the track. This criticism is, however, directly opposed to that contained in his letter of June 5, and which objected to my rules because the centres of gravity of the wheel loads do not lie on a line *diagonally* across the track.

The methods outlined in my article can, subject to the assumptions stated, be applied to most cases, and will lead to consistent results, which cannot be said of the older method referred to by Mr. Padfield. As the assumptions involved in the formula have already been stated, it would appear that no useful purpose can be served by entering into further correspondence on the subject.

Yours faithfully,
E. L. MONTAGNON.

6, Ashmead-road, St. John's, S.E., July 3, 1920.

THE SEA RECORDS OF REINFORCED CONCRETE SHIPS.

TO THE EDITOR OF ENGINEERING.

SIR,—Will you allow me, in the briefest possible space, to give some experiences of the behaviour of concrete vessels which have been made known to me in recent days by owners.

1. A week or two ago, I was in the office of an owner and saw on his wall a photograph of a concrete ship very badly damaged. I remarked jocularly that he wasn't exhibiting his concrete ship in a very good light. On the contrary, he had put the photograph on his wall he said, because he thought it was a very good advertisement indeed for the concrete ship; for, he added, if a steel ship had been in a similar collision it would have cost, he reckoned, 4,000*l.* to repair, whereas the concrete vessel was repaired for 750*l.*

2. I was shown by another owner, careful records, kept over a period of six months, of the upkeep costs of steel and concrete steamers of the same size and in the same trade, and working under the same conditions. *The concrete vessels cost one-fifth of the upkeep of steel vessels.*

3. I have a copy of a letter written by the skipper of a concrete vessel to the builder: "We left Swansea in a gale, when steamers would not sail, and for 24 hours, till we got to the Lizard, we had terrible weather; the pudding fenders and a few more things were missing in the morning but the ship stuck it well."

4. I have before me a letter from the managers of an American 3,500-ton concrete freighter who gave an extract from the log of their captain, who made a special report on the vessel's performance between a Chilian port and the States: "We ran into a gale from N.E. with a velocity of around 65 m.p.h., on December 10, which lasted until December 12. During this gale there was a high sea running, and I must say I never in all my seagoing saw a ship act as gracefully and well. At times, large seas came at her looking as if they would come aboard, and the ship would rise every time, proving she had a great amount of buoyancy. I tried her in the trough and she rolled very easily."

5. A broker sent me an extract from a letter received by him in answer to his inquiries of an owner: "Repairs effected as the result of collisions have not presented the difficulty one usually experiences with vessels of steel construction."

I send you this information as one with no interest in the actual vessels reported on but believing you will be glad to be advised on the matter.

Yours faithfully,
WILLIAM BLACK.

645, Royal Liver Building, Liverpool,
July 6, 1920.

FRENCH COMMERCIAL DEPARTMENT IN ENGLAND.—An exhibition of French products, organised by the "Office Commercial Français en Angleterre," will be held from the 15th to the 30th inst., in the Exhibition Halls, at 153, Queen Victoria-street, E.C. 4.

PERSONAL.—The Société Anonyme Brown, Boveri et Cie., Baden, Switzerland, inform us that Mr. A. C. Eborall—who for many years has been in charge of their interests in Great Britain—has recently been appointed an executive director of the company.—At a special meeting of the Board of directors of S.K.F. Industries, Inc., New York City, held on May 13, the resignation of Mr. B. G. Prytz, as president, was accepted; Mr. Prytz having been elected managing director of the parent company, with headquarters at Gothenburg, Sweden. At the same meeting Mr. F. B. Kirkbride, vice-president since the organisation of the company, was elected president to succeed Mr. Prytz. The Lord President, as President of the Committee of Council for Scientific and Industrial Research, has appointed Dr. J. S. Flett, F.R.S., at present assistant to the Director in Scotland, to be Director of the Geological Survey and Museum. Dr. Flett succeeds Sir Aubrey Strahan, K.B.E., F.R.S., who retires this month, when Mr. G. W. Lamplugh, F.R.S., assistant to the Director in England, also retires. —Mr. H. C. B. Underdown, chairman and managing director of Messrs. Commercial Cars, Limited, has been re-elected president, and Mr. E. M. C. Instone, of the Daimler Company, Limited, has been elected vice-president of the Association of British Motor Manufacturers, Limited.

THE FUNCTIONS OF THE MERCHANT SHIP.*

By Sir NORMAN HILL, Bart., Associate.

WHEN you did me the honour of electing me an Associate of the Institution, you could not have acted under the belief that I was capable of making any contribution of value on the technical side of your work. I know nothing, and you all know that I know nothing of your science, but I have followed for the last thirty years the working of the British Mercantile Marine, and that is my excuse, if not justification, for attempting to state what are the functions of the merchant ships you so largely help to create, and of inviting your consideration of the means which will enable those functions to be best performed.

After the experience of the last six years, it is only a bold man who will attempt to define the functions of the merchant ship. We have seen them used as coal hulks for the Navy from which the coal has been drawn almost ton by ton. We have seen them employed as cold stores for meat brought by the Government into our ports, but for which apparently the country had no immediate need. They have been left in our ports for weeks, and sometimes even for months, to serve as warehouses for sugar, wheat, wool and other commodities imported by the State. We have seen them used as prisons, as landing stages and as breakwaters. We have seen many of them not used at all for month after month. But we have also seen the manner in which the nation has suffered, and is still suffering, through the waste of ship-carrying power.

A ship is a wasting property; its life is limited to, let us assume, twenty-five years, and at the end of that time it passes into the hands of the shipbreakers. It will then cease to be a ship, and become merely a mass of material which has been wrought for one purpose and which can only be applied to other purposes by the expenditure of considerable labour. It follows that the economic value of the ship to the shipowner is represented by the sum of the excess of freights over payments which begin from the time the keel is laid down to the time when the vessel passes into the shipbreaker's hands; and to justify the expenditure the freights received must not only cover working expenses and provided a reasonable return on the capital employed, but they must also be sufficient to replace that capital. The freights are earned in return for the services rendered in delivering all the cargoes that are carried during the ship's life, and therefore the economic value of the ship to the shipowner is determined first by the total number of freights earned, that is by the total number of cargoes delivered, and secondly by the total cost incurred in delivery of those cargoes.

To overseas commerce and to the interests of the producers and consumers in the world which that commerce serves, the economic value of the vessel is determined by the same factors; but whilst the shipowner is concerned with the sum of the excess of freights over payments, the producers and consumers are primarily concerned with the sum of the cargoes delivered. Cost of transport is no doubt of importance, but it is relatively a small matter compared with abundance of supplies in relation to demand. For example, under war conditions the freight paid on the wheat in the quartern loaf advanced ½d., but before the grant of the subsidy the price of the loaf itself increased 4½d. The increased freight did nothing to check the free importation of wheat, and therefore the advance in the price of the loaf during the period of the war would have been as great even if there had been no increase in the cost of carriage, although no doubt over a longer period of years the greater cost of transportation would have reacted on the volume of wheat available in the world to meet the needs of this country.

Regarded therefore, from the point of view of the shipowner, the producer and the consumer, the one and only function of the merchant ship is to deliver cargoes, and delivery connotes: (1) Loading, (2) transportation in safety, (3) and discharging in good condition. What cargoes are to be delivered, and through what ports such cargoes are to pass, is determined by the flow of overseas commerce, which is in the main governed by the needs of the consumers. Those are matters over which the shipowner has no control—it is for him to satisfy the needs as they arise.

These needs are many and diverse, varying not only with the nature of the cargoes themselves, but also with the quantities in which they are shipped, the season of the year in which they are shipped, the capacity of the ports at which they are loaded and discharged, and a variety of other considerations.

As overseas commerce is now carried on, a ship spends about one-half of its life at sea under steam, and the other half in port, engaged in loading and discharging, and in overhauls and repairs. The time spent by the ship in port has been described as lost time, but that surely ignores what is the function of the ship, which is to deliver cargoes at the points at which they are needed, not merely to carry such cargo about on the sea. It follows that the loading and discharging are just as necessary as the transportation of the cargoes, and the time occupied in each of these necessary operations must be reduced to the minimum if the maximum number of cargoes is to be delivered. Thought should not be concentrated on the saving of time in only one of these operations. The overall efficiency of a ship is therefore composed of several factors, and after safety, the most important of all is time, because in measuring efficiency it is the life of the ship and the sum of the cargoes she will carry during that life that must be always kept in view.

Now in what way can the science of the naval architect best contribute to this overall efficiency? That is for you to decide. Safety comes first. What overseas commerce needs and is ready to pay for is delivered cargoes; it profits nothing from lost cargoes. Loss is waste, whether it falls on the merchant, the shipowner, or the underwriter, and it has to be paid for ultimately by the consumers. Safety has been the especial care and study of this Institution, and during the time I have followed the fortunes of the British Mercantile Marine, great, very great, advances have been made. When the war came, our vessels were better built and equipped than ever before in the history of the nation, and the losses were extraordinarily small. We were still seeking for the unsinkable ship, and the war has applied many searching tests to the theories upon which we had been working. This experience is being reviewed by the Institution.

The Institution has also given very careful consideration to the factor of speed and its relation to the cost of its production, and the cargo-holding capacity of the ship. I speak subject to correction, but it would appear that on balance, little is to be gained from increasing the speed with which the voyage is made. Certainly, looking back over the last thirty years, there has been but a small increase in the average speed of the steamships of the British Mercantile Marine. In 1909, I examined the records with some care with the following results:—

From Lloyd's statistical tables I took the speeds of all vessels of 12 knots and upwards, and an analysis of the figures showed that whilst the gross tonnage of these vessels was, in 1894, 2,059,760, and their average speed 13·9 knots, this tonnage had, in 1908, increased to 5,795,338, and the average speed to 14 knots. I was unable to find figures to enable me to determine the average speed of the vessels under 12 knots, but for the purposes of comparison I assumed this average speed at 9·50 knots. On such assumption the average speed of all steam vessels belonging to the United Kingdom, including both those above and below 12 knots, was, in 1894, 10·4 knots, and in 1908, 11 knots.

During the war the losses amongst the faster vessels were very heavy, as they were serving constantly on the more dangerous routes, and these losses have been replaced in part by vessels of the standard types and of lower speeds. The speed of individual vessels attracts the attention of the public, but the number of these fast passenger liners is very limited, and has small effect on the general average. Taking all the available information into consideration, I do not think that the average speed of the steamships of the British Mercantile Marine has increased during the last thirty years by more than about half a knot. If time is to be saved it must, I think, be in port.

In designing the most efficient discharging and loading appliances for the ship, such as winches and derricks, much has been done. In designing vessels capable of loading and discharging with the minimum of labour and in the shortest possible time, particular classes of cargo, such as oil in bulk and coal, much more has been done; but in many ports the ship's appliances do not play an important part in the loading and discharging, and ships designed for the carriage of special commodities and no other, will not meet the general needs of overseas commerce. The utmost dispatch is required in all ports; the great majority of ships must be able to carry not only cargoes outwards, but also homewards, and frequently on cross voyages between the outward and homeward voyage; and the cargoes on all these voyages will never be of only one class of commodity.

In studying the problem how time in port can be saved, there are certain marked tendencies in the development of the ocean overseas trades to be borne in mind. The first is the growth in the size of the ocean-going steamship. From 1860 down to about 1890, there had been but a small increase in the average size of the British steamship employed in ocean overseas trades. Soon after 1890, bigger vessels were built, and this tendency was accentuated right down to the outbreak of war. The Board of Trade records are kept in net tons, but they can be converted for practical purposes into gross tons on the basis of 100 net equally about 166 tons gross. The figures since 1860 are as under:—

Average Tonnage (net as recorded and Gross as estimated) of British Steamships employed in Ocean Overseas Trades.

	Tons Net.	Tons. Gross.
1860	1,322 =	2,200
1870	1,532 =	2,500
1880	1,492 =	2,500
1890	1,597 =	2,600
1900	2,099 =	3,500
1910	2,511 =	4,000

The Board of Trade figures showing the position since the war are not yet available, but from the figures I have seen, I should conjecture that the average tonnage of the vessels now afloat is substantially above the average for 1910. The second tendency in the development of ocean overseas trade is the concentration of the voyages on a limited number of ports, which has followed largely on the growth in the size of the ships. In the United Kingdom this concentration is so marked as to call for careful consideration.

The Board of Trade figures are not very conveniently stated, but it is possible to extract from them an estimate of the volume of traffic both import and export, passing through each of our ports. In such an estimate it will be well to state separately the imports of iron ore, as these are brought into a limited number of ports, and used mainly in their immediate neighbourhood; and also to state separately the exports of coal as the bulk is also handled in a limited number of ports. The actual weights of the greater part of the general imports are shown in the Board of Trade Returns, but the volume of the exports, other than coal, can only be gauged by the shipping net tonnage cleared from each port with cargoes other than coal. The following statement shows the weights of the imports other than iron ore, so far as they can be ascertained, and an estimate of the volume of exports other than coal, dealt with in 12 of our principal ports in the year 1913.

Overseas Trade through Individual Ports.

—	Imports, 1913. Tons Weight. All Imports.	Iron Ore.	Rest.	Per Cent.	Exports, 1913, other than Coal as a Percentage on Total.
		tons.			
London ..	11,342,077	—	11,324,077	25·3	22·9
Liverpool ..	7,222,077	—	7,222,077	16·1	21·3
Manchester ..	2,520,941	—	2,520,941	5·6	2·5
Bristol and Avonmouth	1,675,844	—	1,675,844	3·7	2·5
Southampton	494,746	—	494,746	1·1	12·6
Hull ..	4,262,383	—	4,262,383	9·5	3·8
Newcastle ..	1,482,816	543,809	939,013	2·1	0·5
Cardiff ..	2,545,154	765,955	1,782,199	4·0	—
Grimsby ..	742,618	—	742,618	1·7	2·0
Glasgow ..	2,594,428	1,124,611	1,469,817	3·3	8·1
Leith ..	1,028,553	—	1,028,553	2·3	1·8
Dundee ..	384,656	—	384,656	0·9	0·1
	36,281,293	2,434,369	33,846,924	75·6	78·1
Other ports ..	16,031,720	5,130,687	10,901,033	24·4	21·9
Total ..	52,313,013	7,565,056	44,747,957	100·0	100·0

NOTE.—The tonnage represents the total weights of the imports for which the tonnage, or the means of ascertaining the tonnage are given in the Board of Trade Returns. These imports represent, in value, about 88 per cent. of the total value of all imports.

It will be seen from the above statement that 75·6 per cent. of our oversea imports, other than iron ore, and 78·1 per cent. of our oversea exports other than coal, were in 1913 handled in the 12 named ports. Of the iron ore imports in 1913, 95 per cent. were concentrated on the undermentioned 15 ports; of which only three are included in the 12 principal ports with which I have already dealt.

IRON ORE IMPORTS THROUGH INDIVIDUAL PORTS.

Imports, 1913, Tons Weight.

—	Tons.	Per Cent.
Middlesbrough	2,087,700	27·60
Glasgow	1,124,611	14·87
Cardiff	765,955	10·12
Newport	657,122	8·69
Newcastle	543,803	7·19
Ardrossan	387,973	5·13
Hartlepool	382,612	5·06
Barrow	245,709	3·25
Stockton	202,116	2·67
Grangemouth	198,927	2·63
Ayr	146,761	1·94
Sunderland	140,699	1·86
Maryport	133,499	1·76
Swansea	119,692	1·58
All other ports	427,877	5·65
	7,565,056	100·00

Of the coal exports in 1913, nearly 80 per cent. were concentrated on the undermentioned nine coal shipping centres, of which only two are included in the 12 principal ports.

Exports, Coal, 1913, Tons Weight.

	Tons.	Per Cent.
Cardiff, Barry Docks and Penarth	20,095,051	27·38
Newcastle, North and South Shields... ...	13,619,502	18·55
Blyth	4,475,827	6·10
Newport (Mon.)... ...	4,841,786	6·60
Port Talbot, Briton Ferry, Neath Abbey and Porthcawl ...	2,318,699	3·16
Sunderland	4,027,806	5·49
Swansea	4,451,597	6·06
Burntisland	1,952,030	2·66
Methil	2,594,157	3·53
	58,376,455	79·53
All other ports	15,023,663	20·47
Total coal exports ...	73,400,118	100·00

All these figures point to an extraordinary concentration of traffic on a limited number of the ports of the United Kingdom, but for the purposes of this paper I would direct special attention to the concentration of general traffic on the 12 ports, excluding the iron ore imports and the coal exports.

The third tendency in the development of ocean overseas trade is the growth of parcel shipments, and the decrease of whole cargoes. General trade, both import and export, is depending more and more on the liners carrying mixed cargoes. It is shipped to meet almost the daily needs of individual importers, instead of being left for the purposes of transit in the hands of merchants. Several factors have contributed to bring about this result; the safety and regularity with which the voyages are made has enabled the manufacturers and retailers to buy almost direct from the producers all over the world,

* Paper read before the Institution of Naval Architects, July 6, 1920.

instead of having to draw on stocks already accumulated in this country; and the same considerations have enabled the traders to finance the movement of the particular cargoes in which they are interested. Nearly all international trade is now carried on borrowed money; whilst in transit almost all cargoes are the property of the banks and financial houses which have advanced money on the security of the bills of lading; and the development of the practice of issuing through bills of lading has facilitated greatly not only the purchase of goods in inland centres, but also the carrying through of these financial operations. For the successful working of the shipment and delivery of these general cargoes, elaborate shore organisations are required, and the liner organisations have been built up to meet these requirements.

The effect of all these tendencies is to concentrate the general ocean oversea trade on the ports which can offer the best accommodation to the bigger ships, both as regards berthing and the handling of their mixed cargoes; but all this concentration tells against the quick turn round of those ships in the big ports. It is no easy matter to keep pace with the necessities of the ships by adding to the accommodation in the big ports, and it is a still more difficult matter to increase the carrying power of the railways by which those ports are served. Perhaps the easiest way of meeting these necessities in this country will be by the development of overside delivery and coastwise distribution.

We have ports all round our coasts, although the numbers which are capable of dealing with the big ships is limited, and the greater part of our population is already grouped round those ports. The point is often made that Central Europe and France have derived very great benefit from the systems they have developed of distribution from their big ports over their rivers and canals. These systems have been developed at very great cost, but the facilities they afford fall far below the natural facilities which the United Kingdom enjoys as an island possessing an almost unlimited number of ports. And yet we have been extraordinarily slow in developing coastwise distribution; in the thirty years preceding the war we doubled our ocean oversea trade, but we did not increase out coasting trade. Several causes have contributed to check the development of the coasting trades, and one of the most important has been railway competition. But has everything possible been done towards producing the types of coasters best adapted to receive the cargo from the big ships in the big ports and to deliver that cargo in the small ports? Here, again, time is of the first importance in judging what is best.

I cannot pretend to be able to offer suggestions as to the manner in which ships should be built and equipped, so as to enable them to be loaded and discharged more quickly, but I do believe that it is in national interests an urgent problem, calling for your most careful consideration. I realise that much of the work can only be done in collaboration with the ports; the oil tanker could never have been built if the ports had not been provided with storage tanks; vessels could not have been adapted for the use of grain elevators if the ports had not provided for the storage of grain in bulk; and it would have been waste of time to provide specially for the shipment of coal if the coal tips had not been built. But working hand in hand with the ports and in especial with the big ports upon which the big ships are concentrated—cannot radical improvements be introduced? In the handling of general cargoes, are winches and derricks the last words in loading and discharging appliances?

In the past, many of our steamship lines specialised in their vessels, in build, fitting and equipment to adapt them for the classes of cargo they carried, and the ports they served. Recently the merits of standardisation have been preached from the housetops, but may it not be that what we need is more specialisation if we are to produce the vessel which will deliver the greatest number of cargoes in the trade in which she is employed.

We have many new problems before us. One of them is a desire for a more equitable division amongst the community of the things which are needed to maintain health and comfort. It is not merely the division of money, in wages or in any other form, but of what money represents. In this country our wants must be met in great measure by the supplies we obtain from overseas, and therefore, if the general standard of living is to be raised, the volume of those supplies must be increased. It has been demonstrated that a division carried out by a system of the State rationing such supplies as the State is able to procure can never satisfy our needs. Such a division may be equitable, but it is based on our sharing with one another scarcity—what we want to do is to share in sufficiency.

Another of our problems is the general wish for more leisure, and, amongst many workers, for relief from tasks which are either repulsive in themselves, or which overtax a man's strength. There help can only come from the greater use of mechanical appliances, for if production be not maintained, and if distribution be not carried on, the increased leisure will be spent in poverty, and the relief will be gained at the cost of privation.

A further matter for serious consideration is the enormous growth in the merchant fleets of other countries. Whilst we have devoted our energies and resources to fighting and winning the war, other nations have been building merchant ships. There are difficult times ahead, and we can only hope to hold our position as the great sea carriers of the world by the merits of the services given by the ships under our flag. And in competition, those services will be measured by the sum of the cargoes our ships deliver in safety, and by the cost at which they are delivered.

What oversea commerce requires above all else is facilities to export and import, facilities for the free exchange of commodities, and we in this country feel these needs in an especial degree. It is an abundance in the necessities of life upon which material prosperity and happiness depend. It is given to some to see visions of a new and better world; but if those visions are to be realised, it is for all to work for their attainment. It was the science of the naval architect, working with the skill of the shipbuilders, and the capital and enterprise of the shipowners, that has been the great factor in increasing safety at sea, and in placing at our disposal the produce of the world. Those resources must be used to the utmost in developing the power of our merchant ships to deliver cargoes, if the visions of a healthier and happier Britain are ever to materialise.

THE GERMAN LONG-RANGE GUN.*

By Lieutenant-Colonel H. W. MILLER,† U.S.A.

(*Concluded from page* 30.)

THE ANCHORAGE.

WHEN the German Army had retired from the salient between Soissons and Rheims in August, 1918, the Germans attempted to destroy it, but succeeded only in ripping loose a few plates. At the time the emplacement was captured, no description of any kind was available of the carriage for which it was intended. The writer's failure to find any emplacement in Belgium from which the mount examined there could be operated led to further examination of the emplacement in France, and it was found that they fitted perfectly.

The emplacement is in two main sections, one a base and the other a rotating section. The rotating section, which is shown in Figs. 16, 17 and 18, is about 28 ft. 6 in. in diameter and is supported on one hundred and twelve 8-in. steel balls. The base of this section is about 35 ft. in diameter and 6 ft. in depth. In Fig. 14 there can be seen at right angles to the direction of the track of the rotating section two girders, on the ends of which are key plates or pads. The plate which is labelled has six holes in it, and the plate on the opposite end of the girder has eight.

The mount is run on to the emplacement with the rotating section in the position shown in Fig. 14. It is then raised by the four jacks, which can be seen at the left of Fig. 14, and are shown in their exact positions

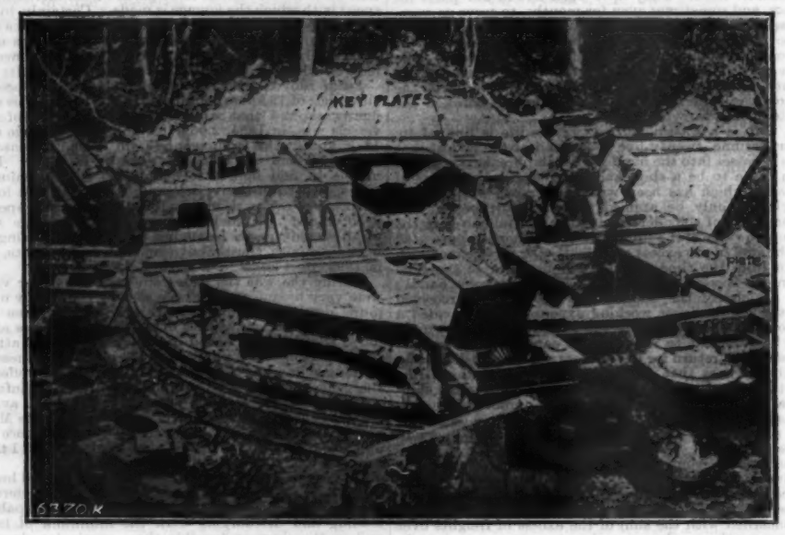


FIG. 14. EMPLACEMENT (BOIS DU CHATELET).

FIG. 15. ANOTHER VIEW OF EMPLACEMENT SHOWN IN FIG. 14.

emplacement shown in Figs. 14 and 15 was found in the Bois du Chatelet, 9 km. directly north of Chateau-Thierry. This emplacement was in process of installation, and had not been completely erected. The in Fig. 16. When the mount is raised the trucks are removed and the rotating section of the emplacement turned through 90 deg. On lowering the mount on to the emplacement, the key plates on the bottom chords of the carriage are fitted to the corresponding key plates on the emplacement. A gantry crane running on the tracks shown in Fig. 16 was used in the construction of the emplacement.

The carriage on which the gun is so mounted as to be capable of movement in a vertical plane only is traversed by rotating the top section of the emplacement. A complete circular traversing rack made up of angles and

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† Office of Chief of Ordnance, Artillery Division, Washington, D.C.

steel pins is bolted to the structural base. A pinion carried on a vertical shaft on the side of the rotating section which corresponds to the rear of the carriage engages with this rack, and the mechanism is driven by two two-man handles on a horizontal shaft carrying a worm engaging with a worm wheel on the top of the vertical shaft, as shown at the right of the plan, Fig. 16, on this page. This shaft may likewise be driven by means of the four handles mounted on the two cases in the centre of the rotating section and connected with the worm wheel and shaft through two shafts carrying two universal joints each. Apparently the mount was generally traversed by means of the latter handles, if one may judge of the scheme of operation shown in a photograph of the gun in action.

Fig. 16.

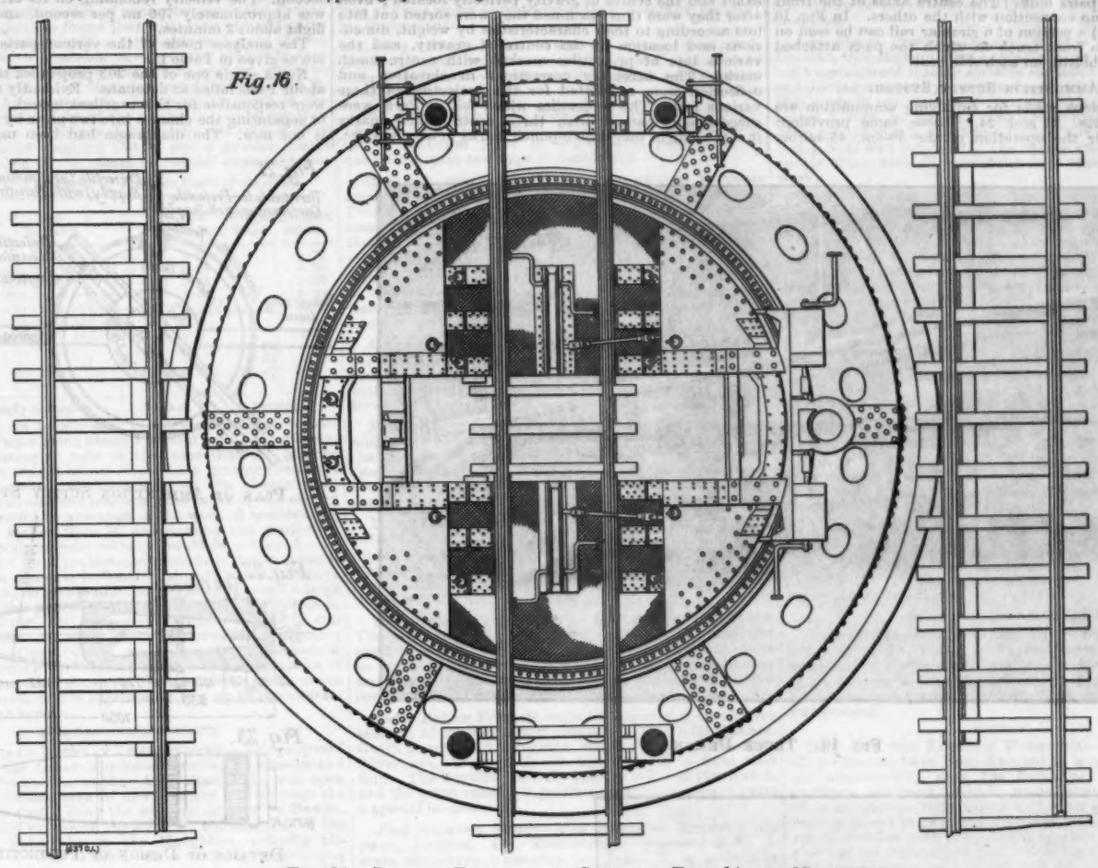


FIG. 16. PLAN OF EMPLACEMENT SHOWN IN FIGS. 14 AND 15.

Fig. 17.

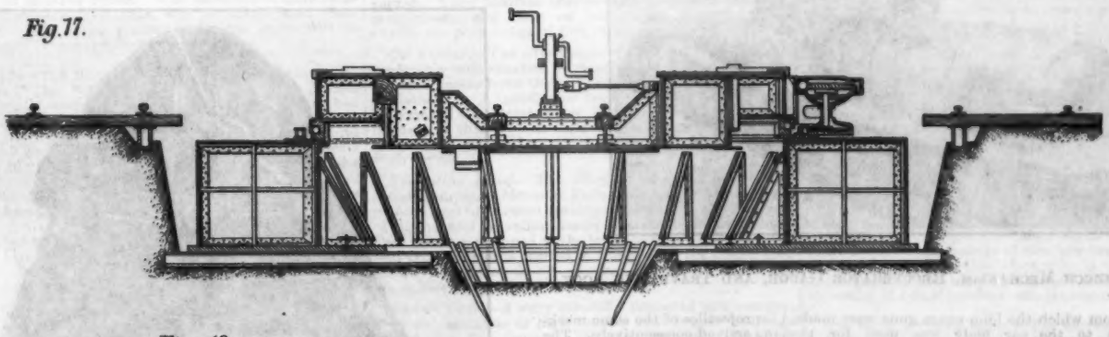
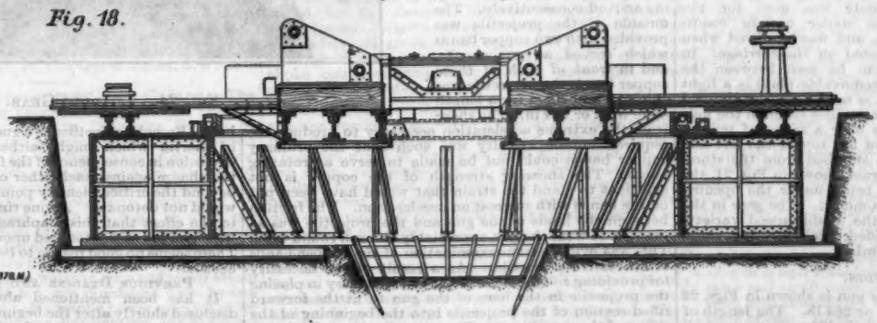


Fig. 18.



FIGS. 17 AND 18. ELEVATION OF EMPLACEMENT SHOWN IN FIGS. 14 AND 15.

Camouflage.—In the case of the emplacement found in the Bois du Chatelet, sockets were placed in the centre of the approach track at intervals of about 30 ft., into which trees with trunks up to about 6 in. in diameter could be placed for the purpose of concealing these tracks. A photograph of the gun in action indicates that a netting covering was stretched over the mount from the trees on either side, and a view taken during construction shows the gantry crane as well as the emplacement, while in the process of installation, covered with tree branches.

Trucks.—All of the trucks, as well as the span bolsters, are constructed entirely of structural steel, as shown in Fig. 19. The front trucks contain five axles each, and the rear trucks four axles each. The journals are approximately 14 cm. in diameter by 22 cm. in length. The wheels are 95 cm. in diameter. On the front trucks three wheels are provided with two brake shoes each;

on the rear trucks the end wheels are provided with two shoes each and the inner wheels with one shoe each. The braking is done by hand only. The axles are equalised in pairs only. The centre axles of the front trucks have no connection with the others. In Fig. 10 (page 29, *ante*) a portion of a circular rail can be seen on the top of the front truck on which the pads attached to the span bolster on each side bear.

Ammunition Supply System.

The provisions made for supplying ammunition are shown in Figs. 21 and 24. These same provisions were used for the operation of the 38-cm. 45-calibre naval guns from which the long-range guns were made. An extension to the car body was used for the operation of the 38-cm. gun under certain conditions. This was not required, and was removed when the long-range gun was operated on the carriage. In Fig. 24 a removable plate can be seen between the shot-truck rails. Above this removable plate is a light bridge, in the centre of which is seen a ball on the end of the cable used in hoisting projectiles through the hole in the floor. This cable runs over a series of pulleys to a small drum in the box on the top of the left-side girder. The ammunition was supplied from the store-house over the narrow-gauge track shown in Fig. 21, the circular portion of the track being under the opening in the centre of the floor of the mount. The gear in the box on the side girder is of the double-speed variety, the high speed being provided probably for rapid operating in the hoisting of powder.

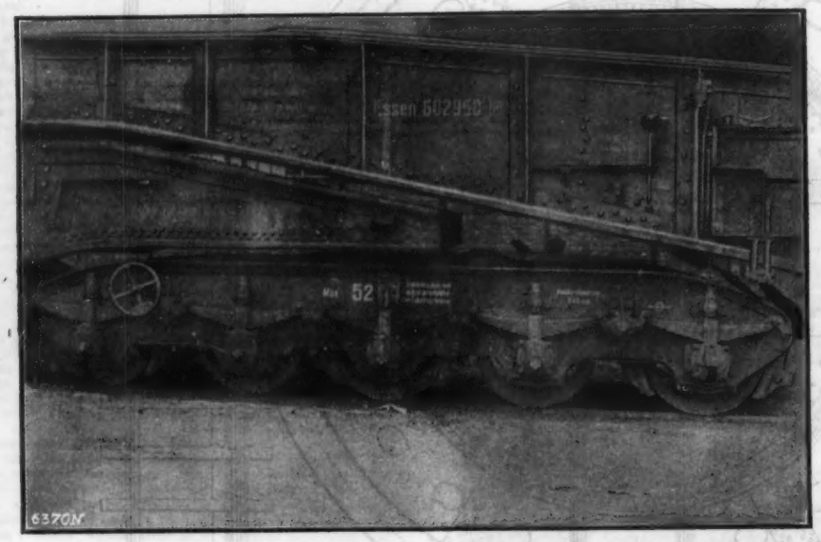


Fig. 19. Truck Design.

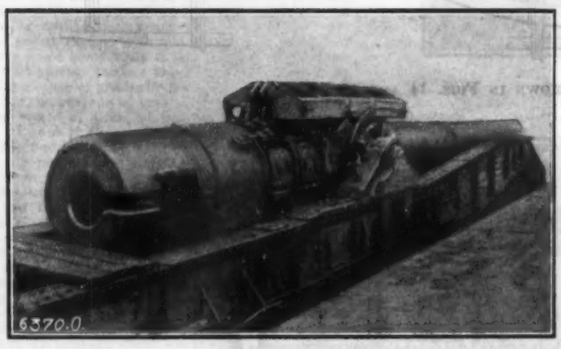


Fig. 20. Breech Mechanism, Recuperator Gauge, and Travelling Lock.

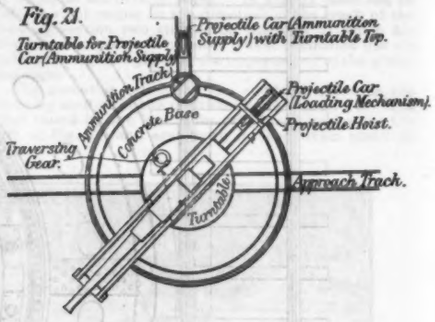
Ammunition.

The projectile used with this gun is shown in Figs. 22 and 23. Its weight is 120 kg., or 264 lb. The length of the main portion of the projectile is 490 mm., or approximately 19 in. To this was attached a false ogive or cap, the exact length of which is not known; it was probably as long, if not slightly longer, than the main portion of the projectile. The radius of the curve of this ogive was about 7 calibres or 58 in. The design of the interior as well as the exterior of this projectile is unique in many respects. It will be noted that the charge was separated into two parts by a diaphragm which has a number of holes in it. Two fuses are used, the one in the diaphragm and the other in the base. All of these projectiles were most carefully machined to elaborate specifications in order that the weight and dimensions might be practically exact and the centre of gravity perfectly located; even after they were thus machined they were sorted out into lots according to their characteristics by weight, dimensions and location of the centre of gravity, and the various lots of projectiles marked with centre-punch marks. The necessary corrections in elevation and deflection were calculated for the projectiles of these various lots. The projectiles which fell in Paris were successively marked with three centre-punch marks in a triangle or four centre-punch marks in a square, &c.—projectiles of the same marking arrived consecutively. The outside of the projectile was provided with two copper bands which served as gas checks, and in front of each of these copper bands the projectile was enlarged and rifled for a length of 70 mm. or 2·7 in. The shear from the extreme acceleration necessary to produce the required muzzle velocity was such that the ordinary copper bands could not be made to serve as rotating bands. The shearing strength of the copper is not sufficient to stand the strain that would have been put on the bands with so great an acceleration. The friction between the lands of the gun and the projectile was so great as to wear the gun appreciably on each round fired. This was evident from examination of the copper bands of successive projectiles. As a result of the necessity for providing rifled projectiles, it was necessary in placing the projectile in the bore of the gun to fit the forward rifled section of the projectile into the beginning of the rifling of the gun, Fig. 4. The exact details of the design of the portion of the tube between the beginning of the rifling and the powder chamber are not known. It seems quite probable, however, that there is a smooth section of about 12 in. into which the portion of the projectile back of the first copper band fits, bringing the base of the projectile to the end of the powder chamber. The fact that the forward rifled section of the projectile was already fitted into the grooves of the gun made it certain that the rifled section at the rear would likewise fit as the projectile began to move up the gun. It has been noted before that this projectile departed at a muzzle velocity of from 1,500 m. per second to 1,600 m. per second. The velocity remaining on its arrival in Paris was approximately 700 m. per second, and the time of flight about 3 minutes.

The analyses made of the various parts of the shell are as given in Table II.

Not a single one of the 303 projectiles that fell in or about Paris failed to detonate. Evidently the two fuses were responsible for this excellent record. The practice of separating the charges into two parts by a diaphragm is not new. The diaphragm had been used before in

Fig. 21.



Plan of Ammunition Supply System.

Fig. 22.

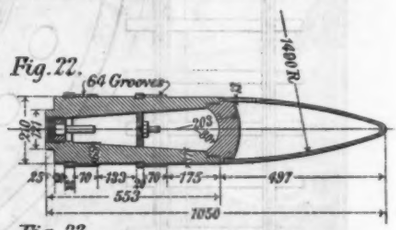


Fig. 23.

Details of Design of Projectile.

Fig. 24. Loading Gear.

previous guns—projectiles of the same marking arrived consecutively. The outside of the projectile was provided with two copper bands which served as gas checks, and in front of each of these copper bands the projectile was enlarged and rifled for a length of 70 mm. or 2·7 in. The shear from the extreme acceleration necessary to produce the required muzzle velocity was such that the ordinary copper bands could not be made to serve as rotating bands. The shearing strength of the copper is not sufficient to stand the strain that would have been put on the bands with so great an acceleration. The friction between the lands of the gun and the projectile was so great as to wear the gun appreciably on each round fired. This was evident from examination of the copper bands of successive projectiles. As a result of the necessity for providing rifled projectiles, it was necessary in placing the projectile in the bore of the gun to fit the forward rifled section of the projectile into the beginning of the rifling of the gun, Fig. 4. The exact details of the design of the portion of the tube between the beginning of the rifling and the powder chamber are not known. It seems quite probable, however, that there is a smooth section of about 12 in. into which the portion of the projectile back of the first copper band fits, bringing the base of the projectile to the end of the powder chamber. The fact that the forward rifled section of the projectile was already fitted into the grooves of the gun made it certain that the rifled section at the rear would likewise fit as the heavy French projectiles as a guarantee against the effects of inertia which might either provoke a premature explosion in consequence of the friction of the molecules of the charge against each other or might bring the charge beyond the critical density point, after which it probably would not detonate. At one time a theory was advanced to the effect that this diaphragm separated two liquids which mixed and detonated upon the fall of the projectile. There seems no good reason to believe that this could have been so.

Previous Designs and Limits in Design.

It has been mentioned already that investigation disclosed shortly after the beginning of the bombardment that an almost identical design had been proposed to the French Government not many years before. Further search of French and English records has brought to light the fact that the rifled projectile is quite old and seems to antedate the copper band considerably. In 1892 Sir Alfred Noble made a 100-calibre 6-in. gun which gave a muzzle velocity of 3,700 ft. per second; in the same year the French Government constructed a 10-cm. 80-calibre gun from which they attained almost the same muzzle velocity. It is not known what range was secured

in either case. The forms of most standard projectiles at that time were not such, however, as to make it possible to secure the maximum range from the above-noted velocity.

In taking up the design of such guns again the French and English services found that with guns of practicable length and muzzle velocities attainable with guns of such length, and with available powders, the projectile that would permit the greatest range to be realised would be approximately 8 in. in diameter, weighing from 225 lb. to 250 lb. An appreciable change up or down in the diameter or the weight of the projectile would result in a loss of range. The gun designed by one of our allies uses a projectile weighing 240 lb. and a powder charge of 350 lb. One of the pieces of powder examined was

TABLE II.—*Analyses of Various Parts of the Shell.*

–	Shell.*	Cap Holder.†	Cap.	Diaphragm‡	Copper Band.	Dunkirk Shells.
C	0·42–0·85	0·58–0·72	0·10–0·18	0·60		0·72
Mn	0·27–0·49	0·27–0·36	0·41–0·97	0·09		0·26
Si	0·24–0·31	0·19–0·28	0·03–0·05	0·61		0·23
S	0·04–0·10	0·03–0·07	0·05–0·11	0·04		0·03
P	0·01–0·06	0·03–0·07	0·04–0·067	0·04		0·04
Ni	1·82–2·32	2·10–2·39	0·00–0·11	0·0		2·41
Cr	0·83–1·45	0·95–1·44	0·00–0·2	0·0		1·32
Pb					0·12	
Fe					0·21	
Cu					99·67	

* Practically a casting. † Cast. ‡ Forging.

about 2½ ft. in length and roughly elliptical in cross-section, the axes being about 1 in. and ¼ in., respectively. It is interesting to note in this case that the powder charge has a weight about 50 per cent. greater than that of the projectile. If the weight of the charge were increased, calculations indicate that most of the energy of the gas would be absorbed in the work of accelerating the charge rather than in accelerating the projectile, and no greater muzzle velocity would be obtained.

One of the vital requirements made of the powder is that it burn at a rate sufficiently slow to avoid excessive pressures and to give a uniform pressure through a large portion of the period of the travel of the projectile in the bore of the gun. The powder made by one of our allies for their long-range gun is in flat strips resembling cardboard. These strips are three-ply, the various sections burning at different rates. The large sticks of powder mentioned above for the gun of the other of our allies is special, and is expected to live up to the characteristics just noted.

QUEENSLAND RAILWAY DEVELOPMENT.—The proposed linking of the Great Northern Railway of Queensland with the Bowen line in that Australian State, will open up a considerable area of new country and shorten the distance for traffic from the western country to Bowen. The proposed extension suggests the construction of the line from Bobawaba to the Haughton, crossing the Burdekin at The Rocks, or a railway connecting Bobawaba and Ravenswood by a rack railway, or the selection of another route. It is understood that large quantities of coal and coke will be taken west from Bowen and also large quantities of iron stone will be carried from Cloncurry to Bowen smelters.

BUSINESS WITH SOUTH AFRICA.—A new organisation, known as "The South African Association of British Manufacturers and their Agents," has been established in Johannesburg with the object of safeguarding the interests of United Kingdom manufacturers in South Africa, and generally of promoting British trade interests in the Union. The association was formed with the assistance of a number of prominent representatives of United Kingdom firms. The first annual meeting was held on April 27 last, when the title of the association and its draft constitution and rules were adopted. It is proposed later to open a branch at Cape Town, and also to institute a considerable number of trade sections. In order that the association may be made as representative as possible, it is suggested that any United Kingdom manufacturers interested in trade with South Africa, who are not already members, should consider the desirability of joining the body. Membership is confined to United Kingdom manufacturers and their South African agents. Copies of the constitution and rules of the association are available at the Department of Overseas Trade, 35, Old Queen-street, S.W. 1.

WATER-POWER DEVELOPMENT IN CANADA.—The Dominion Water Power branch of the Canadian Department of the Interior, and the Dominion Bureau of Statistics have completed a census of the development of water power, say *Engineering News Record*, New York, according to which there are installed throughout Canada some 2,418,000 turbine or water wheel horse-power, of which 2,215,000 are regularly employed. Of the total power installed 1,756,791 h.p., or 72·7 per cent. is in central electric stations, i.e., where power is developed for sale and distribution. In the pulp and paper industry 473,265 h.p. are utilised, of which 381,631 h.p. are generated directly from water in pulp and paper establishments, while 91,634 h.p. are purchased from hydro-central electric stations. Hydraulic power used for other purposes is listed as follows: For lighting, 434,613 h.p.; the mining industry, 177,728 h.p.; in flour and grist mills, 42,736 h.p.; in lumber and saw mills, 37,918 h.p.; and in other manufacturing industries, 172,955 h.p. The total installation is comprised of 3,370 units of an average capacity of 715 h.p. The figures of 70 representative hydro-electric stations with an aggregate turbine installation of 743,797 h.p., show a total construction cost of 50,740,468 dols., or an average of 69·11 dols. per installed horse-power.

CATALOGUES.

Water Measurement.—The Lea Recorder Company, Limited, 28, Deansgate, Manchester, sends several long lists of firms which have adopted their waterflow measuring instruments.

Lifting Blocks.—The Vaughan Crane Company, Limited, Openshaw, Manchester, has issued a price list of their blocks, trolleys and travellers, which were recently noticed in these columns.

Cast-Iron Pipes.—The Stanton Ironworks Company, Limited, near Nottingham, sends a copy of a monthly list of cast-iron pipes in stock, with particulars of quantities, sizes and type of connection.

Steels.—A catalogue of steels for various purposes comes from Messrs. W. Gilbertson and Co., Limited, Pontardawe, near Swansea, containing clear descriptive matter and useful tables, test figures and other information.

Excavating Machinery.—American shovelling, grabbing scraping, crushing and tipping machinery is illustrated in a small introductory catalogue issued by Messrs. George F. West and Co., Iddesleigh House, Westminster, London.

Motor Car Equipment.—The Brolt systems of motor car lighting and starting are dealt with as to fitting and maintenance in a very clearly-written little booklet, with large scale wiring diagram, issued by Messrs. Brown Brothers, Limited, Great Eastern-street, London, E.C. 2.

Fans.—Blowing and exhausting fans, and steel-plate multi-vane fans, are shown in catalogues received from the Sturtevant Engineering Company, Limited, 147, Queen Victoria-street, London, E.C. 4. The explanatory matter is helpful and the dimensions and particulars of capacity are clearly arranged.

Turret Lathe Tools.—A 16-page catalogue from Messrs. Alfred Herbert, Limited, Coventry, shows a very large number of tools and fixtures for turret lathes made to standard measurements. The catalogue is evidence of the firm and increasing hold which the turret lathe has in modern engineering workshops.

Time Recorder.—A catalogue from the Gledhill-Brook Time Recorders, Limited, Huddersfield, explains several applications of their system of printing time and dates on cards to give an automatic check on working hours and special jobs, and shows facsimile reproductions of a considerable variety of record cards.

India Rubber Products.—An historical and descriptive account of the works and products of the India Rubber, Gutta Percha and Telegraph Works Company, Limited, Silvertown, London, E. 16, has reached us from that firm. The booklet is clearly printed and well illustrated, and the great variety of products described gives it quite a special interest.

Fuel Economy Tester.—The Blackman Export Company, Limited, 374, Euston-road, London, N.W. 1, state that every 1 per cent. too little CO_2 in boiler-flue gases indicates a waste of 2 per cent. of the fuel consumed. They mention that a waste of over 6 per cent. is common, and offer an inexpensive instrument to enable the percentage of CO_2 to be ascertained.

Oil Burner.—The advantages of using a blast of steam, preferably superheated, to heat, spray and atomise the oil as it passes from the burner to the furnace is clearly explained in a catalogue from Messrs. Hooper and Weyman, 11, Carteret-street, London, S.W. 1, who make burners of this type at their Newcastle-on-Tyne works. A record is given of a test of 6 hours' duration in firing with tar oil.

Travelling Hoist.—The Shepard Electric Crane and Hoist Company, Montour Falls, New York, sends a well-printed and illustrated catalogue describing their system of lifting and travelling loads on a fixed overhead rail. Two rails are clamped to the lower flanges of a steel joist, and the operator is carried in a cage with the lifting gear which is operated by electric motors. The lifting capacities range from 5 cwt. to 10 tons.

Switch Gear.—A very carefully prepared and comprehensive catalogue of high tension switch gear has been issued by the General Electric Company, Limited, 67, Queen Victoria-street, London, E.C. 4. Full particulars are given of all apparatus for high-tension switches including tension limiters, lightning arresters, choke coils, isolating links, relays, time limit fuses, static leakage detectors, &c.

Steam Traction Engines.—A fine series of steam traction engines is shown in a special catalogue received from Messrs. Ruston and Hornsby, Limited, Lincoln. These are made in four sizes with single cylinders and five sizes, compound. They are intended for general haulage work, farm work and two convenient sizes can be converted for road rolling. All the parts are clearly described, and full particulars of powers, capacities and dimensions are given.

Steam Boilers.—A catalogue of boilers, mainly of the locomotive and other internally-fired types, comes from Messrs. Robey and Co., Limited, Lincoln. Nearly all these are complete steam raising units, easily portable and ready to be put to work without building in. They can be supplied mounted on four wheels, and also with a special fire-box when sawdust or inferior fuel is to be consumed. A method of withdrawing the fire-box and tubes bodily for cleaning is described.

Traction Engines.—Messrs. William Foster and Co., Limited, Lincoln, send a catalogue showing a very fine series of traction engines for haulage and driving work of medium and large power. Single and compound engines fitted with all necessary attachments for various classes of work are supplied. A special type for hauling and driving a threshing machine is made, and a furnace for burning straw can be fitted when required. Petrol engine tractors of 40 h.p., 60 h.p. and 100 h.p. sizes are also shown in the catalogue, which is exceptionally well produced.

Agricultural Tractor.—Messrs. Alldays and Onions, Limited, Birmingham, send a catalogue of a substantially-built agricultural tractor suitable for hauling, ploughing and driving machinery—in fact, for all work on the farm. It is made in two sizes of 20 h.p. and 30 h.p., and is well under 3 tons in weight. The three road speeds are 1¾ m.p.h, 2½ m.p.h. and 5 m.p.h., and a reverse speed of 2 m.p.h. is also provided. The engine runs on paraffin and is fitted with all accessories for varied agricultural work.

Central Exhaust Engines.—The advantages of the "uniflow" or central exhaust steam engine are very clearly stated in a carefully reasoned preface to a special catalogue issued by Messrs. Galloways, Limited, Manchester. These advantages are mainly claimed for continuous running and non-reversing work, for which a good supply of condensing water is available. The engine is economical for a varying load provided the drive is continuous. Fourteen standard sizes are listed ranging from 150 i.h.p. to 2,500 i.h.p. from a single cylinder. The largest size has a cylinder 60 in. in diameter, with a 72-in. stroke, and runs at 63 r.p.m. with a working pressure of 160 lb. per square inch.

Telephones.—Independent telephone systems for internal use in offices, works and other establishments have developed on three main principles: (1) Central switchboard with an operator in attendance or (2) multiple wiring, or (3) automatic. The third is automatic in the sense that it dispenses with the characteristic features of (1) and (2) and indicates if a required connection is already engaged. Messrs. Siemens Brothers and Co., Limited, Palace-place Mansions, Kensington Court, London, W. 8, send a catalogue describing their automatic system which is intended for up to 50 connections, but can be extended to 200. The construction and method of operation are clearly explained and the instruments are of the standard post office pattern.

BRITISH CHAMBER OF COMMERCE IN SWITZERLAND.—We read in *The Board of Trade Journal* that British interests in Switzerland are establishing a Chamber of Commerce at Basle. A branch of this will be in Lausanne to act more particularly in regard to French Switzerland.

NEW USE FOR ELECTRIC FURNACES.—Electric ferro-alloy furnaces have been diverted to a most interesting use commercially, says *The Iron Age*, New York. A southern company, which made synthetic pig-iron, ferro-manganese, ferro-silicon and other similar products during the war in its electric furnaces, found itself after the armistice faced with the problem of discovering a profitable use for its equipment. Prices for ferro-manganese and low phosphorus pig-iron had declined, and in the production of certain other alloys there was keen competition. The result of wide investigations has been the manufacture in this type of furnace of phosphoric acid and potash on a fairly large scale. For making phosphoric acid, phosphate rock is smelted in the electric furnace the phosphorus being driven off as phosphoric oxide, suspended in the gases. These are collected and treated by the Cottrell electrical precipitation system, in which the phosphorus compounds are collected electrically as a fine powder. By further treatment and concentration a superior product is obtained, free from any of the impurities which are present when sulphuric acid is the disintegrating agent. In the manufacture of potash, southern shales are similarly treated, with the formation of oxides of potassium in the gases and their electrical precipitation and collection. The substitution of electricity for expensive chemicals in these interesting cases is not only a feature of this new practice, but there is the other novelty that electricity is used both as the destroying or breaking-down agent and as the medium by which the final products are recovered.

OIL FROM RUBBER SEED.—The current number of the "Bulletin of the Imperial Institute," discusses in detail the possibility of utilising the large quantity of seed now being produced on rubber plantations. In the early stages of the rubber industry in the Middle East the seeds were mostly used for raising plants for making new plantations, but as there are now at least 1,000,000 acres under rubber trees the quantity of seed available is much in excess of the planting requirements. It was shown many years ago by investigations made at the Imperial Institute that the kernels of Para rubber seeds yield a large amount of oil similar in properties to linseed oil, and that this oil can be used for paint-making and other purposes for which linseed oil is employed, whilst the cake which is left after the oil has been removed from the kernels is an excellent feeding-stuff for live-stock. Until the last year or two, the oil had only been produced on an experimental scale, but at least one oil mill is now established in Malaya for crushing rubber seeds and small commercial consignments of the oil have been sold recently in this country and in Marseilles at good prices. Whether it will pay the planter to supply the seeds to an oil mill depends very largely on the cost of collection, a point on which experts differ. In view of the present necessity for the exercise of rigid economy on rubber estates and of the enormous demand for oils and feeding-stuffs, it is highly desirable that serious efforts should be made to organise the collection of Para rubber seed wherever it is likely to prove at all profitable and so prevent waste of a material which is undoubtedly of considerable value.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in Italics.

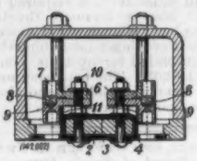
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

ELECTRICAL APPARATUS.

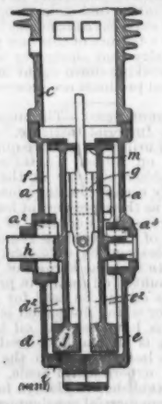
142,022. A. Parkinson, Leeds, and F. and A. Parkinson, Limited, Leeds. Terminal Plates and Sockets. (2 *Figs.*) September 19, 1920.—The invention relates to terminal plates and terminal sockets for use in electrical installations. According to the invention, a terminal socket comprises two members, each consisting of a plate and a socket, the plate of one member having a spigot and the plate of the other member a hole to accommodate the spigot. Also, a terminal plate comprises the combination with a frame having a bridge or member extending from side to side, of a plurality of terminal sockets of the kind described above mounted on said bridge and insulated therefrom. The terminal plate is built up on a rectangular frame having a bridge 2 integral therewith extending from one side to another. This bridge 2 is covered on one face and on two sides with a layer 3 of micanite or other insulating material of "U" shape, and on the other side a sheet 4 of similar insulating material is secured



thereto. Mounted upon the bridge 2 and insulated therefrom is a plurality of terminal sockets. In the terminal plate illustrated, which is intended for use with a three-phase supply of electricity, there are six of these terminal sockets mounted in two rows. Each terminal socket comprises two members and each member comprises a plate 6 having formed in one therewith a socket 7, in which a lead can be sweated or brazed. Further, the plate 6 of one member is provided with a spigot 8, and the plate 6 of the other member with a hole 9 to receive the spigot 8. In use, the two members are placed with the two plates 6 in contact, and the spigot 8 engaging its hole 9, and secured upon the bridge 2 by means of a bolt 10. One of the terminal sockets 7 extends downward in relation to the bridge 2, and such socket is provided on the part 11 that comes adjacent a side of the bridge 2 with a flat for the purpose of preventing angular movement between the terminal socket and the bridge or member, and so preventing adjacent terminals from touching. (*Accepted May* 12, 1920.)

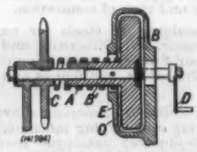
GAS ENGINES, PRODUCERS, HOLDERS, &c.

142,312. C. Roe, Birmingham, and H. Roe, Birmingham. Two-Stroke Engines. (2 *Figs.*) May 14, 1919.—The invention relates to a two-stroke internal combustion engine of the kind in which the explosive charge is first drawn into the crank-case to subsequently feed the cylinder from said case. *a* is the crank-case and *c* the cylinder, and *d* and *e* the flywheels having bearings at a^2, a^3. *f* is the crank chamber. According to the invention, the faces of the flywheels *d* and *e* have fairly deep sinkings, d^2, d^3, e^2, e^3, of circular shape, arranged eccentrically to the crank-pin *g*, to the drive shaft h and to the circumference i of said flywheels, and in such manner that the thicker parts *j* of the rims of the flywheels are radially opposite the crank-pin



on the other side of the shaft h. Said sinkings are all similar and the flywheels are rigidly connected so that said sinkings are coincident, and each is regular in formation, or uniform with the others, there being a sinking in each face of each flywheel of the same depth and diameter and with preferably square sides *m*. The purpose of the sinkings is mainly a more efficient displacement of the gases from the crank chamber to the cylinder on the outer stroke of the piston, and a more efficient suction from the crank chamber on the gas supply pipe during the in-stroke of the piston, by which a much better slow-running of the engine is obtained, and at higher speeds more uniform power strokes, but, secondarily the formation of and the action of the sinkings assist the balance of the engine. (*Accepted May* 12, 1920.)

141,284. J. M. S. Marriner, Glasgow. Starting Apparatus. (3 *Figs.*) October 22, 1919.—The invention relates to internal combustion engines. The mechanism connecting the starting handle with the engine shaft is so designed that the starting torque is transmitted from the handle through a flywheel of appreciable inertia, which is elastically connected by means of a spring with the engine shaft, in such manner that while the torque necessary for turning the engine shaft involves the axial displacement of the flywheel to an extent which does not interfere with the continued rotation of the starting handle, any seriously greater strain of the starting mechanism consequent, for example, on a backfire of the engine, causes a further axial movement of the flywheel in the same direction and thereby relieves the shock which would otherwise be communicated to the starting handle. D is the starting handle; B is a flywheel



of some inertia; A is the spring connecting the flywheel with the sprocket wheel C which drives the engine through a chain. The flywheel and sprocket wheel shafts are discontinuous and have sufficient end clearance to enable the flywheel, guided by its sleeve B1, to slide towards the left to the required extent. When the handle D is turned to start the engine, the power has to be transmitted through the spring A, which winds itself up a little, and the flywheel B is consequently drawn towards the left, but not sufficiently to engage with the facing E which is fixed to the frame of the engine. If a backfire occurs, the sudden shock has to overcome the inertia of the wheel B, and a greater strain than is necessary to turn the engine is put on the spring A so that it winds itself up sufficiently to draw the wheel B against the facing E. The friction material O reduces considerably the shock which would come on the wrist of the person turning handle D. (*Accepted May* 12, 1920.)

GUNS AND EXPLOSIVES.

142,299. J. R. Bayes, London, and C. T. J. Vautin, London. Water-Cooled Automatic Guns. (4 *Figs.*) May 5, 1919.—The invention relates to water-cooled machine guns, in which water is circulated through the barrel casing by a pump worked by the recoil action of the gun when in action. In a gun according to this invention, there is employed a multiple orifice nozzle in direct communication with the delivery chamber of the pump, and located in the rear wall of the barrel casing, and so arranged that the streams of water are directed directly on to the end of the barrel remote from the muzzle. *a* is the pump, it being attached to the rear of the barrel casing *b*. The pump has a delivery valve *e*, normally pressed down by a spring and delivers the water into a distributing device or nozzle *f* projecting into the barrel casing *b*. This nozzle *f* is perforated at *g* so as to direct the water in streams as it is delivered into the casing *b*,

Fig. 1.

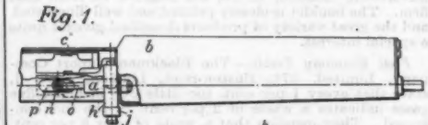
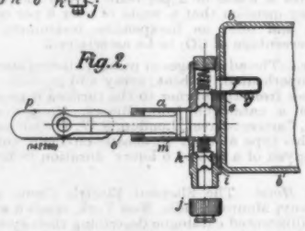


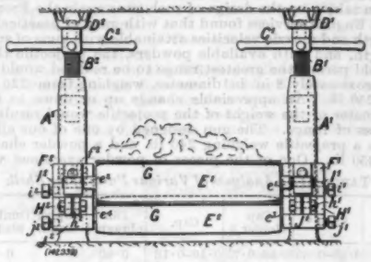
Fig. 2.



on to the end of the barrel remote from the muzzle. The suction h of the pump is fitted with a spring-controlled valve *i*, and is provided with a removable protection cap *j* for use when the gun is not in operation. The pump *a* is positioned on the lower part of the casing *c*, and is parallel with the barrel. The plunger or piston *m* of the pump *a* is actuated by the recoil of the barrel through a pin *n* which is screwed into the end of the piston rod *o*, passed through a dust cap or plate *p* and a slot in the casing *c*, over which the dust cap or plate *p* works with the piston rod, the end of the pin engaging a projection on the barrel. When it is desired to remove the barrel, the pin *n* is unscrewed sufficiently to bring it clear of the projection on the barrel which it normally engages. Thus as each round is fired, and the portion of the gun which recoils is moved to and fro', the pump plunger is worked, and water is sprayed on to the barrel at the end remote from the muzzle. (*Accepted May* 12, 1920.)

MINING, METALLURGY AND METAL WORKING.

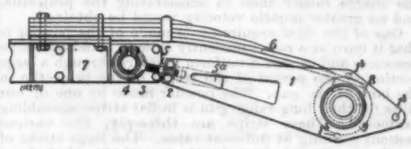
142,339. R. Sutcliffe, Wakefield. Belt Conveyors for Mines. (2 *Figs.*) June 12, 1919.—The invention relates to belt conveyors for mines and more particularly to the means for supporting the belt or band. According to the invention, the belt runs on rollers supported in bearings carried by clamps which can be adjusted to the required vertical height and horizontal direction on props of steel tubing. An upper and a lower roller are provided, one each prop for supporting, respectively, the loaded and return portions of the belt. The clamps may be formed as straps encircling the props secured in the required position by bolts passing in the usual manner through holes in the ends of the straps. Each roller is carried in the bearings of a pair of props placed on either side of the belt. A^1 and A^2 are props, the lower ends of which rest on the floor of the gallery and the upper ends are screw-threaded to receive screws B^1, B^2, which can be raised by arms C^1, C^2, so that the caps D^1, D^2, press against the roof of the mine or gallery. The journals e^1, e^2, of the roller E^1 are carried by clamps F^1, F^2, encircling the props A^1, A^2, and tightened by bolts f^2. These rollers support the upper loaded part of the belt G. The journals e^3, e^4, of similarly arranged rollers E^2 are carried by clamps H^1, H^2, tightened by bolts A^1, A^2, and support the return portion of the belt G. Below the clamps F^1, F^2, are collars I^1, I^2, secured to the props A^1, A^2, by set screws i^2, i^2, and below the clamps H^1, H^2, are similar collars J^1, J^2, secured by set screws j^2, j^2. If the bolts f^1, f^2, A^1, A^2, are loosened, the clamps can swivel about the props A^1, A^2, so that the journals e^1, e^2, of the rollers take up



a correct alignment in their bearings and with the belt G. By lowering the screws B^1, B^2, the props can be easily removed or adjusted in a new position. (*Accepted May* 12, 1920.)

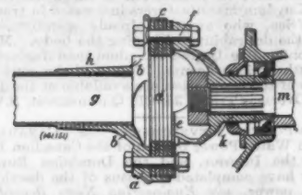
MOTOR ROAD VEHICLES.

142,171. H. R. Godfrey, Thames Ditton, and "G. N." Limited, Hendon. Automobile Vehicles. (2 *Figs.*) January 24, 1919.—The invention relates to automobile vehicles of the class known as light cars. The object of the invention is to provide an improved suspension. The improved suspension, according to the invention, comprises radius members, each having two side elements, a tubular member provided with flanges at either end mounted on the axle between such side elements and engaged thereby, and a spring is arranged to bear upon a cushion of fibre, which is rounded on its lower surface so as to enable a rotary sliding motion to take place between the tubular member and the cushion and is flat on its upper surface



to permit the end of the spring to slide over such surface. 1, 1, are the side elements of the radius member, which are connected together by rods 1b; 2 is to the fore portion thereof by means of which the radius member is secured by an eyebolt 3 with the pin 4, nut member 5 and 5a, the latter having a conical end engaging in a correspondingly formed hole in the fore portion 2, being provided for adjusting the effective length of the radius member. The quarter elliptical spring 6 is secured to the bracket 7, on which the pin 4 is also formed, and the end of the spring bears upon a fibre block 8 which rests upon the flanged tubular member 9, through which the back axle passes and which is engaged between the side elements and is secured in fixed relationship therewith by means of the rods 1b serving to connect together the side elements. (*Accepted May* 12, 1920.)

141,151. John I. Thornycroft and Co., Limited, Westminster, and T. Thornycroft, Westminster. Universal Joint. (1 *Fig.*) February 15, 1919.—The invention relates to that class of joint in which, for the purpose of transmitting motion from one rotary member to another, an annulus of leather or equivalent flexible material is attached at a certain number of points to a spider carrier on one rotary member and at other intermediate points in the same circumferential line to another similar carrier on the adjacent rotary carrier, the annulus of flexible material accommodating itself to alteration in the angle that may occur between the rotary members which are respectively provided with the spider carriers. In a coupling of this kind the connection of the flexible annulus to the carriers is effected by means of bolts passing through the material of the annulus, and whilst torsional stresses can be very effectively transmitted through such a connection, due to the bolts being spaced in a common circle and subjecting the material to both compression and tensile stresses, the object of the present invention is generally to improve the coupling by providing means in association with one of the carriers adapted to better preserve the annulus in effective working condition. To this end it is arranged that the annulus shall be supported circumferentially



in the region of the several devices connecting it to both carriers, by means independent of such devices. In this way the tendency of the flexible annulus to buckle under compression is lessened or prevented, and other advantages secured in certain services, such as the maintenance of one of the rotary members in position upon failure of the coupling where the function of the latter is also to, in part, support the rotary member. The invention has been particularly devised for motor vehicle driving equipments. The bosses *a* of a three-armed coupling flange *b* are cast in one with a ring *c*, serving to engage exteriorly and retain a set of leather coupling rings *d* sewn together as ordinarily. The companion three-armed coupling flange *e* is not modified and the connecting of both to the set of coupling rings *d* is effected by bolts *f*, also as ordinarily. The coupling flange *b* is attached to the universal shaft *g* of a motor vehicle chassis. The weight of such shaft will be taken in part by the metal ring *c* that encircles the set of leather rings *d*, and such metal ring will retain the shaft in position even though the leather coupling rings *d* have become destroyed, or have fallen out through breakage. The flange *b* is formed in one with a sleeve *h* that is brazed on the shaft *g*, and the flange *e* is formed in one with a sleeve *k* connected to the driven shaft *m*, but such details of construction are immaterial to the invention. (*Accepted April* 21, 1920.)